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RESEARCH IN OSTEOPATHY

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Research in Osteopathy

by

Dr. J. Deason and Associates

BULLETIN No. 2

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FOREWORD

In offering the results of these various series of experimental work to the profession it seems only fair that the following facts should be known.

1. That the experimentors had little previous experimental work upon which to build.

2. That the experimentors were usually working under adverse circumstances as the laboratory equipment was often insufficient and the work had to be planned according to the conditions. Much of the work planned and begun had to be abandoned or changed because of circumstances.

3. Some of the work reported was done for the purpose of making other work possible in the future—thus the seeming lack of purpose.

4. Two series Nos. 13 and 14 are lacking because they are not at present completed.

5. Much of the work done is incomplete because of the conditions under which the work was done.

J. D.

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AN EXPERIMENTAL STUDY OF THE AUTONOMIC NERVOUS SYSTEM, ITS RELATION TO THE CENTRAL NERVOUS SYSTEM AND REFLEX EFFECTS

SERIES NO. 1.

J. DEASON, M. S.

The purpose of this work was to determine what experimental methods could be used in the study of physiological principles pertaining to the osteopathic theory.

About one hundred animals, dogs and cats were used. All animals were operated under ether anesthesia as will be explained in detail in the following series.

This work was done in Dr. Deason's laboratories in the A. S. O. during the school year of 1909 and 1910. About forty animals were used and some general facts were determined such as:

1. That stimulation of the central end of any spinal or cranial nerve is equal in effect to the stimulation of the peripheral end of a spinal autonomic nerve.

2. That the phrenic nerve contains sensory fibres and that stimulation of its central end gives similar effects to the stimulation of the central end of other nerves which contain afferent fibres.

3. That osteopathic manipulation applied to the spine in animals caused certain variations in respiration, heart beat and blood pressure, which were measured in some instances, but this work was not completed.

The results of this work have never been published but they have been used as a working basis in other series.

SOME PHYSIOLOGICAL EFFECTS OF VERTEBRAL MOVEMENTS EXPERIMENTALLY PRODUCED

Series No. 2.

J. Deason, M. S.

In this series of experiments, the purpose has been to determine the relation of perverted positions and abnormal movements of the spine to structural perversions and abnormal movements of other parts of the body, and to determine the physiological effects resulting from such operations.

It should be mentioned at the beginning that this work is necessarily very incomplete, because little or no work has, as yet, been done along this line, and the literature, therefore, is sadly lacking. I am much indebted to Mr. L. G. Robb for his valuable suggestions and able assistance.

Methods and Technique of Experiments.

Much care has been exercised in the selection of animals for these experiments. Dogs were used, because blood pressure and pulse tracings can be more readily obtained from these than from smaller animals, and no animal was used which had not been kept for a sufficient time under normal conditions to determine that it was entirely devoid of any abnormalities which might render the results valueless. The spine was carefully examined in each case, to determine that no bony lesions existed before proceeding with the operations.

Reasons for the above precautions will be better understood when the reader is reminded of the fact that the average dog is frequently found suffering from constitutional diseases, many of which are traceable to spinal lesions, the evidence of which statement we hope to bring out at some future time.

It is a well known fact to all workers in physiological research, that not all animals exhibit average normal functions when operated on under anesthesia. It is necessary, therefore, to experiment on several animals, and take the average results of those which seem to display the most normal reactions under the anesthetic used. The following results have been taken from a common average of ten animals operated upon.

During the operation the animals were kept under complete and regular anesthetic by ether, which was administered by means of a tracheal cannula, as it is most satisfactorily regulated in this way. Blood pressure and pulse tracings were taken from the carotid artery by the use of a carotid cannula and mercury manometer.

Respiratory tracings were taken from the side arm of a T tube, connected on the one hand to the tracheal cannula, and on the other to a diaphragm tambour, which was made to record on the smoked paper of a revolving kymograph, simultaneously with the blood pressure and pulse tracings mentioned above. An electric signal magnet, connected with an inductorum and metronome was used to record time, and furnish a base line.

Several normal blood pressure and respiratory tracings were taken from each animal before any tests were applied, to determine whether or not the animal was showing normal functional activities. From five to ten minutes were allowed before and after each test for normalization. All results from animals whose tracings failed to show normal activities before any tests were applied, were discarded.

PRELIMINARY TEST TO DETERMINE RELATION OF THE POSITION OF THE ANIMAL TO BLOOD PRESSURE VARIATIONS.

The caudal end of the animal was elevated, thorax remaining on the table, to determine blood pressure variations thus effected. Extreme tilting of the body, such as lifting of the caudal end, or relative lowering of the cephalic end, brings about marked increase in blood pressure, due to the effect of the force of gravity, but in the above operation, in which only a part of the animal was lifted, the increase in blood pressure was not great, seldom

exceeding two millimeters of mercury, nor was the result a lasting one, as the pressure returned to normal within ten to fifteen seconds after replacement of the caudal end upon the table. The animal was then placed in different positions, such as ventrum on operating board, dorsum on operating board, and changing from side to side, and the blood pressure, pulse and respiratory variations thus produced were not great, but were carefully noted for comparative purposes.

Effects of Pressure and Massage.

Constant and intermittent pressures were applied to various parts of the body, not in immediate relation with the spine, to determine effects of cutaneous and deep pressure stimulation. Slight variations in blood pressure, heart rate and respiration were usually, but not always, thus effected. Such changes were not constant, a return to normal being noted almost immediately upon removal of the pressure.

Vigorous massage was applied to different parts for the same purpose, and unless long continued the results were inconsiderable. Rapid and vigorous movements of different muscles and groups of muscles were also produced, using the limbs as levers. The variation in blood pressure, heart rate or amplitude, thus effected, were neither marked nor constant, as is shown in the first part of tracing No. 1, in which the hind leg was vigorously flexed and held against the abdominal wall for twenty seconds, causing an increase in blood pressure of one millimeter of mercury, a return to normal occurring immediately upon removal of the stimulus.

The second part of tracing No. 1, shows similar results, which were caused by the flexion of one leg tightly across the abdominal wall. It will be noted in these two tracings that ample time was allowed for a return to the normal before each stimulation was produced.

Effects of Movements of the Spine without Fixation.

By fixation we mean the localization of movement. One vertebra is fixed, holding it either by the transverse

or spinous processes, producing a localization of movement at the point fixed.

In movements of the spine without fixation, the effects were similar to those of massage, compression or movements of the limbs, as mentioned above. The blood pressure, pulse rate and respiration were usually affected, but there was a quick return to normal after the animal was replaced in its normal position.

The different tests applied were flexion and extension, hyper-flexion and hyper-extension, and lateral flexions and hyper-flexions, care being taken to keep the animal's body level, so that the gravity factor might be neglected.

Tracing No. 2 shows effect of flexion without fixation. In this test, the whole caudal end of the animal was strongly flexed, and held so for twenty seconds; an increase in blood pressure of two millimeters of mercury was produced, but the rate and amplitude were not affected. Further, the increase in blood pressure was not maintained, but an immediate drop to normal was observed upon restoration of the body to its normal position.

This increase in blood pressure was due either to the position of the animal or to the compression of the caudal vessels, tending to force more blood into the thoracic region, and thus raise the pressure in the carotids from which tracing was taken. It will be noticed that these effects were only temporary, in contradistinction to the effects induced by flexions and extensions with local fixation which are described below.

Effects of Movements of the Spine with Fixation.

Various movements of the spine were produced, such as extension, hyper-extension, flexion and hyper-flexion, both ventral and lateral, by holding the cephalic end of the animal and using the caudal end and hind legs as a lever while certain vertebræ were held, thus producing an exaggerated movement at, or immediately caudal to, the point of fixation. Rotations were produced by fixing certain vertebræ and twisting the caudal end of the animal.

Careful tracings of blood pressure, pulse rate, amplitude and respiration were taken while the various move-

ments were being produced. When any noticeable variations resulted from such movements, sufficient time was allowed for the animal to return to normal before another test was applied.

These various movements were produced with and without fixation in each animal, and the results compared. In all tests applied with fixation, the effects were much more marked and of longer duration than those in which no fixation was employed.

To remove the possible gravity effect on blood pressure changes in the above operations, where it might be argued that a part at least of these effects were due to the raising of the caudal end of the animal, or to vasoconstriction in and pressure on the vessels of the hind limbs, the abdominal aorta was ligated in the lumbar region, below the branches to the viscera, and the ascending vena cava was ligated in the lumbar region after draining the blood from the caudal extremeties. The animals were then allowed to remain quiet for a few minutes until the blood pressure tracings became regular and normal, after which tests were repeated, with similar results.

Tracing No. 3 was made after such an operation. The lower line shows the normal heart tracing before the test was applied. The upper line shows the result of hyperextension of the caudal end of the animal, with fixation in the mid-dorsal region, which was maintained for five minutes. This tracing shows an immediate increase of blood pressure of eight millimeters of mercury which lasted for twenty seconds, and that an increase of five millimeters of mercury above normal was maintained for three minutes after the stimulus was removed.

In all of these operations the body of the animal was kept lying level while applying the test, lest gravity might possibly enter in as a causative factor in the variation of the blood pressure.

To determine whether the stimulation of the viscera mechanically by such operations, or the stimulation of the sensory endings could by reflex effect, account for such changes, the viscera, stomach and intestines of a few animals were removed and the abdominal walls on both

sides were resectioned and the tests again applied. This operation was carefully done by ligating all vessels, thus avoiding the loss of blood by hemorrhage; intravenous injection of warm normal salt solution was used when necessary, and the exposed surfaces were carefully protected by pads of absorbent cotton, saturated with warm normal salt solution.

Tracing No. 4 was made after the above described operation, which also included the ligation of the abdominal aorta and the inferior vena cava. The tracing shows the result of hyper-extension of the caudal end, with fixation at the twelfth dorsal. An immediate decrease of fifteen millimeters of mercury in blood pressure resulted, which continued to decrease as long as this position was maintained, which was more than sixty seconds. The pulse had very nearly stopped when the extension was released.

After restoring the animal to its normal position, the blood pressure and pulse returned to normal, which showed that the effect could not have been due to shock resulting from the operation or exposure.

Effects of Constant Pressure Applied to Spinal Regions.

This was tried on both operated and unoperated animals, by pressing constantly upon the transverse processes in various regions, kymograph tracings being made as in the above operations. Variations in blood pressure were greater in the unoperated animals, which was probably due to the pressure of the greater blood area of the mesenteric arteries.

Tracing No. 5 shows the result of constant pressure applied to the lumbar region for twenty-five seconds. The result was a decrease in blood pressure of twelve millimeters of mercury which lasted for two minutes after the stimulation was removed. There was also some decrease in amplitude, but no noticeable variation in the rate of heart beat.

Tracing No. 6 shows the result of a similar pressure applied to the region of the tenth and eleventh dorsals. This shows a gradual increase of blood pressure, but no other marked effects.

Deep pressure tests were applied to various parts of the spine, but we have not as yet been able to do enough work to determine definitely the results of such experiments. It must be remembered that this is only a preliminary report, and the work is very incomplete, and cannot be taken as a final conclusion.

In the above series of experiments we have observed that different areas or regions of the spine seemed to produce different functional effects from these perverted positions and pressures, but as yet little work has been done experimentally, so we urge that it not be accepted as conclusive.

From the above pressure tests, the fact that the two different regions seem to be very different in their effects upon blood pressure is seemingly undeniable, as movements of the spine with local fixation in these regions produce somewhat similar results.

Tracing No. 7 shows a marked decrease in blood pressure, and amplitude of heart beat, which were caused by rotation of the caudal end of the animal, with fixation at the sixth lumbar. (The dog has seven lumbar, and thirteen dorsal vertebræ.)

Tracing No. 8 shows a marked decrease in blood pressure, which was caused by a rotation of the caudal end of the animal with fixation between third and fourth lumbar. This variation could not possibly have been due to any gravity effects, because the caudal end of the animal was elevated while the rotation was produced.

Summary.

While this series of experiments, as has been repeatedly stated above, is only preliminary, and cannot be taken as final, enough work has been done to show quite conclusively that certain movements of the spine, normal and abnormal, and especially those in which fixation was employed are much more effective in producing functional variations than movements or massage of other parts of the body. In the future we hope to offer some suggestions on the possible physiological explanation of this, which will be based upon experimental evidence.

That these changes cannot be accounted for by gravity effects, we think is sufficiently evident from the preliminary tests made and because of the precautions observed to avoid it, as have been described.

That the massage effects could not possibly be responsible for these changes is clearly shown by the nature of the effects produced in that way. Massage, when vigorously applied to any part of the body, does produce blood pressure, pulse and respiratory variations, but in all cases, even when continued for a much longer time than the time given to the spinal movements and pressures, the results are not so great, or of long duration, but quite conversely returning to normal almost immediately after the massage was discontinued. While the blood pressure and respiration are usually slightly increased, the amplitude and rate of heart beat are usually unaffected. Massage, in its effect upon animals under anesthesia, therefore, is almost wholly incomparable to movements of the spine with fixation.

The effects of movements of the spine without fixation are very similar to passive movements of other parts of the body. There is always an increase in blood pressure and respiration, but usually no noticeable variations in heart rate and amplitude, and the variations are of short duration as compared to movements of the spine with fixation. Even when hyper-extensions and hyper-flexions were employed the changes so effected were not at all comparable to changes caused by these movements with fixation.

The effects of movements of the spine with fixation, localized movement at some one point, causing an excess of movement or partial temporary subluxation, seemed to be most effective in the production of functional variations. Blood pressure and respiration, being affected in all cases, and in many instances the heart rate and amplitude of heart beat was also affected.

Insufficient work has been done to enable us to determine with any degree of accuracy the exact effect of spinal pressure. From the work which has been done it would seem safe to say that spinal pressure in many ways stimulates spinal movements produced with fixation, always vary-

ing the blood pressure, usually the respiration, and frequently affecting changes in heart rate and amplitude.

It is evident that such pressures have wholly different effects on blood pressure and rate of heart beat when produced in different areas of the spine, possibly affecting the socalled spinal centers.

The accompanying tracings which have been selected as typical representations of more than a hundred made during the operations, represent the characteristic changes caused by the different tests applied, and are not in any way exaggerated.

Conclusion.

From the results of this series of experiments, we have arrived at no hasty conclusion in stating quite definitely that of all the different tests which we have described above, those movements which affect the spine in such a way as to produce conditions comparable to the osteopathic bony lesion are the most efficacious in producing abnormal variations in certain vital physiological processes, as have been described.

Granting that this be true, does it seem unreasonable to conjecture that other functions, such as peristalsis, secretion, metabolism, etc., would be similarly affected?

ON THE PATHWAYS FOR THE BULBAR RESPIRATORY IMPULSES IN THE SPINAL CORD[1]

SERIES No. 3.

BY J. DEASON AND L. G. ROBB.
(From the Hull Physiological Laboratory, University of Chicago.)[2]

The experiments summarized in this report were carried out at the suggestion of Professor Carlson with the view of testing out a possible explanation of the Porter experiment on the spinal respiratory pathways.[3]

On repeating the well-known Porter experiment with a group of students in advanced physiology of the central nervous system, Professor Carlson found that after hemisection of the cervical cord and section of the opposite phrenic nerve in young kittens the respiratory impulses do not cross the median line in the cord if the animal is in a state of depression at the time of section of the phrenic. In such an animal, however, dyspnoea induces crossing of the impulses. Dyspnoea also leads to crossing of the impulses without previous section of the opposite phrenic nerve. This would seem to show that the crossed pathways for the respiratory impulses are normally open, and that their use depends upon the relative intensity of the impulses discharged from the bulbar centre.

The crossing of the respiratory impulses in the Porter experiment may be: 1. A case of opening up of new reflex paths. The chief objections to this explanation are that the crossing takes place practically instantaneously on section of the opposite phrenic; and that dyspnoea induces the crossing, without the section of the opposite phrenic.

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1 Reprint from the American Journal of Physiology. Vol. XXVIII.—April 1, 1911,—No. 1.

2 This work was begun in the Hull Physiological Laboratory but was finished in the research laboratories of the authors at Kirksville, It is reprinted here because some of the principles are of special interest to osteopathic physicians and research workers.

3 Porter: Journal of Physiology, 1895, XVII, p. 455.

2. The section of the phrenic may raise the excitability of the phrenic and the bulbar respiratory centres, and thus increase the intensity of the respiratory impulses. In this case the Porter experiment becomes simply a special case of the spread of the reflex (or automatic) responses *pari passu* with the increased intensity of the stimulus (or the nervous impulses).

The second hypothesis demands the phrenic nerves contain afferent fibres, whose stimulation increases the intensity of the respiratory impulses; and that the crossing should be induced by the stimulation of any sensory nerve that causes an increase in the intensity of the bulbar respiratory discharges.

Method.

Kittens and dogs were used in these experiments. The kittens were chosen because of the rapidity with which they recover from shock. The movements of the diaphragm were observed by clipping the hair from the lower part of the thorax and abdomen, and noting external movements; by making an incision in the linea alba and applying digital palpation, and by direct observation of the diaphragm, both intact and divided into lateral halves by an incision from the xiphoid process to the spine.

The respiratory tracings were taken by connecting a tambour with the side arm of a T tube, which was placed between the ether bottle and the trachial cannula. In some of the experiments simultaneous blood pressure tracings were taken from the carotid artery.

All work was done with the animal under complete ether anesthesia, care being taken to make this light and uniform.

Results.

Confirmation of Porter's experiment. In all of our experiments it was found that after hemisection of the cord in the upper cervical region (2nd or 3d segments) the diaphragm on the side of hemisection was paralyzed, and provided the animals were in good condition, section of the opposite phrenic nerve immediately started the respiratory rhythm in the diaphragm on the side of the hemi-

section, followed by permanent paralysis of the diaphragm on the side of the sectioned nerve.

Porter assumes that "the section of the phrenic nerve interrupts the ordinary respiratory pathway on the same side, and a greater portion, perhaps the whole descending impulse of that side passes through the crossed dendrites to the phrenic cells of the opposite side." Unless the passage of the bulbar respiratory impulses from their spinal conduction path to cells of origin of the phrenic motor fibres depends in some way on the normal impulses of afferent fibres in the phrenic; or unless the mere section of the phrenic motor fibres by antidromic impulses immediately blocks the passage from the spinal conduction paths to the phrenic cells, there is no reason for assuming such an "overflow" of the impulses to the opposite side.

The crossing of the bulbar respiratory impulses at the level of the phrenic nuclei after hemisection of the spinal cord can be induced by traction on the phrenic nerve of the intact side of the cord. The traction need not be great enough to block the impulses in the nerve. In fact, if it is properly adjusted, a uniform respiratory rhythm is induced in both sides of the diaphragm. Two typical protocols are submitted for illustration.

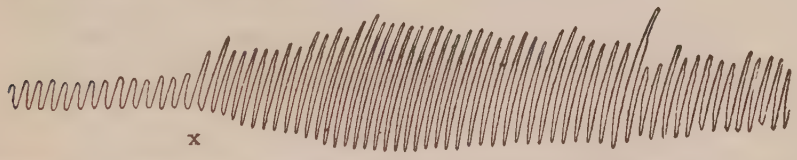

FIGURE 1. — One half the original size. Cat. Hemisection of the spinal cord in third cervical segment. Tracing of the respiratory movements via the tracheal cannula. *X* = ligation of the phrenic nerve on the opposite side of the hemisection. Increased activity of the respiratory centre.

Experiment 33.—Young cat in good condition. Ether.

10:15 A. M. Animal anesthetized.
10:26 A. M. Diaphragm exposed.
10:35 A. M. Left phrenic isolated.
10:43 A. M. Diaphragm divided from xiphoid process to spine, and artificial respiration started, both sides of diaphragm contracting evenly.
10:58 A. M. Cord hemisected in 2nd cervical segment, right side. Very little hemorrhage. Right half of diaphragm paralyzed.
11:04 A. M. Left phrenic stretched until right diaphragm contracted.

11:05 A. M. Both sides of diaphragm contracting evenly. Inspected at intervals of from three to five minutes until 11:51.

11:51 A. M. Both sides of diaphragm contracting evenly. Animal killed. Post-mortem showed complete hemisection of the spinal cord.

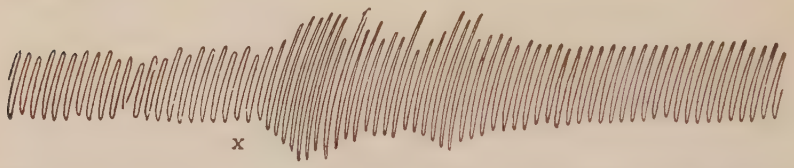

FIGURE 2. — One half the original size. Cat. Tracing of respiratory movements via the tracheal cannula. *X* = section of the left phrenic nerve after previous hemisection of the right side of the spinal cord between the second and third cervical vertebræ. Increased activity of the respiratory centre.

Experiment 38.—Adult cat. Ether.

4:20 P. M. Abdomen opened. Diaphragm exposed.

4:26 P. M. Cervical cord exposed.

4:28 P. M. Left hemisection. Left side of diaphragm paralyzed. No hemorrhage.

4:36 P. M. Artificial respiration started and diaphragm sectioned from ensiform process to spine.

4:41 P. M. Right phrenic isolated just above diaphragm. Trauma of isolation caused crossing of impulse. Diaphragm examined at intervals of three to five minutes and both sides were contracting equally at 5:40.

5:41 P. M. Animal killed. Post-mortem showed complete hemisection of the spinal cord.

Stimulation of the central end of the sectioned phrenic nerve causes an increase in both rate and amplitude of the respiratory movements, preceded in some cases by a

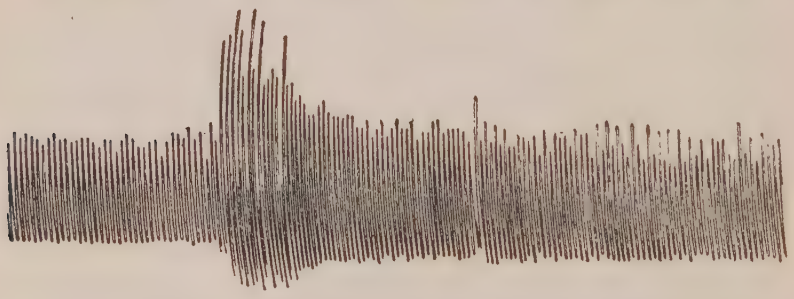

FIGURE 3. — Four fifths the original size. Cat. Tracing on stimulation of the central end of the left phrenic nerve, right phrenic nerve intact. Increased activity of the respiratory centre.

slight inhibition or irregularity. The effects on the blood pressure are similar to those following the stimulation of the central end of any sensory nerve. Mechanical stimuli, i. e., ligation and pressure on the phrenic nerves, gives the same results as electrical stimulation.

Typical tracings illustrating this phenomenon are reproduced in Figs. 1—5. Weak stimuli tend to augment the intensity of the respiratory discharges, while strong

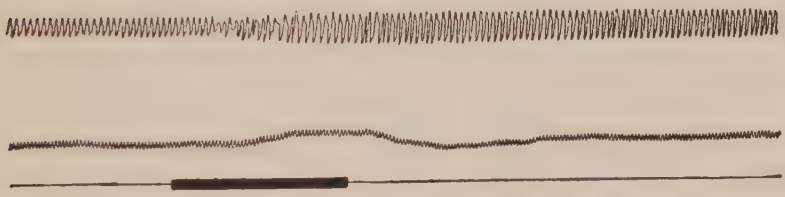

FIGURE 4. — Two fifths the original size. Cat. Tracings of the carotid pressure and the respiratory movements. Both phrenic nerves sectioned. Stimulation of central end of left phrenic nerve. Increased activity of the respiratory centre.

stimuli augment both the rate and intensity of the impulses. The effects may persist for two to ten minutes after the cessation of the stimulation. The fact that the afferent phrenic fibres are strongly stimulated by the mere sectioning of the phrenic seems to show that this is a factor in the immediate crossing of the respiratory impulses in the

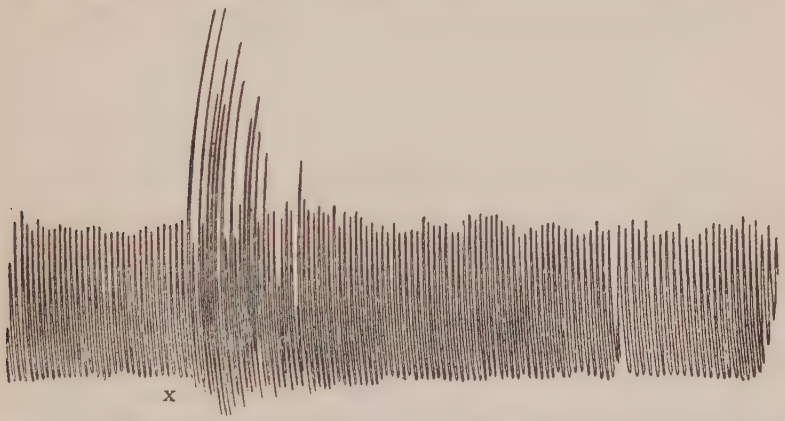

FIGURE 5. — Eight ninths the original size. Cat. Respiratory tracing via the trachea cannula. *X* = light traction on central end of the left phrenic nerve. Increased activity of the respiratory centre.

Porter experiment. But, as the crossing persists, according to Porter's observations, after such stimulation of the afferent fibres due to the section of the nerve has presumably ceased, other factors must also be involved, possibly an increased excitability in the phrenic nuclei, due to injury currents and products of degeneration.

Stimulation of the sciatic nerve induces crossing of the respiratory impulses and an equal contraction of each lateral half of the diaphragm, which may continue for ten minutes after the cessation of the stimulation.

One typical experiment may be cited for illustration.

Experiment 26.—Kitten. Ether.

3:50 P. M. Cervical cord exposed.

3:54 P. M. Abdomen opened.

3:56 P. M. Diaphragm sectioned from xiphoid process to spine. Artificial respiration started.

4:05 P. M. Cervical cord hemisected, right side; right half of diaphfagm paralyzed.

4:15 P. M. Electrical stimulation, central end of right sciatic. Both sides of diaphragm contracting equally and synchronously.

4:25 P.M. Right half of diaphragm ceased contracting.

4:29 P.M. Electrical stimulation, central end of right sciatic. Respiratory rhythm of entire diaphragm.

4:31 P. M. Right side of diaphragm ceased contracting.

4:34 P. M. Electrical stimulus central end of right sciatic. Both sides of diaphragm contracting.

4:36 P. M. Right side of diaphragm ceased contracting.

4:40 P. M. Artificial respiration stopped for twelve seconds. Right side of diaphragm contracting.

4:40:12 P. M. Artificial respiration started.

4:40:27 P. M. Right diaphragm ceased contracting.

4:44 P. M. Left phrenic sectioned. Left side of diaphragm paralyzed. Right diaphragm contracting.

4:50 P. M. Animal killed.

Summary and Conclusions.

1. The phrenic nerves contain afferent fibres, the stimulation of which augments the intensity and the rate of the bulbar respiratory impulses. The effects of stimulation of these fibres on the respiratory centre outlasts for varying lengths of time the period of stimulation.

2. After hemisection of the spinal cord between the medulla and the phrenic nuclei and consequent paralysis of the diaphragm on the hemisected side, the bulbar respiratory impulses will cross from the intact to the hemisected side of the spinal cord on stimulation of the sciatic nerve; on traction or mechanical stimulation of the phrenic

nerve on the intact side of the cord; in dyspnoea; as well as on section of the phrenic nerve on the intact side. These various conditions induce increased intensity of the bulbar respiratory impulses. The immediate crossing of the bulbar respiratory impulses on section of the phrenic nerve after previous hemisection of the opposite side of the cervical cord seems therefore to be a case of the spread of reflex (or automatic) responses *pari passu* with the increased intensity of the nervous impulses. But since in the Porter experiment the crossing of the impulses appears to be permanent, additional factors are probably involved.

RELATION OF SPINAL LESIONS TO CARBOHYDRATE METABOLISM

SERIES No. 4.[1]

J. DEASON, D. O.[2]

The original purpose of this series of experiments was to determine the relation of the spinal bony lesion to carbohydrate metabolism. Later, however, several other problems have arisen, such as the relation of these lesions to nutrition, normal functions of the stomach and intestines, gastro-intestinal infection, etc.; therefore some preliminary notes will be offered on these subjects in the summary of this article.

LITERATURE.

In reviewing the literature of the experimental work which has been done on the relation of the pancreas and other organs to carbohydrate metabolism, we find the following to report: It would seem that here as well as in most other functional disturbances that not only one, but in many cases, several structures are involved, and considering, as all physiological experimenters now well understand, the fact that many, or possibly all, organs of the body bear a certain essential functional relationship with each other, we can see how a disturbance of the function of one structure might easily affect the functional activity of another.

That either direct or indirect interference with the nerve supply to the pancreas and other related structures plays an important part in the production of glycosuria, we offer the following evidence from the literature:

Effects of total extirpation of the pancreas. Pfluger believes the fact that glycosuria which follows the extirpation of glands as generally attributed to the nervous phenomena would warrant a careful consideration of nervous

1 Published first in the Journal of the A. O. A. June 1911.

2 I am greatly indebted to Mr. L. G. Robb for assisting in the care and lesioning of the animals, to Mr. A. R. Bell for conducting the urinalysis and to many other students for helping with the care of the animals in various ways.

elements in pancreatic glycosuria. After a consideration of the cases of partial extirpation of the pancreas cited in the literature, Pfluger concludes that in these cases where glycosuria occurred the cause lay in the nervous disturbances. All, or practically all, of the investigators agree that after partial extirpation of the pancreas glycosuria is exceptional rather than general. Pfluger attributes the results of J. Thiraloix, who holds that there is invariably glycosuria resulting after partial extirpation, to poor technique in the removal of the pancreas and accompanying injury or violent stimulation of the nerves. Likewise, in H. Luthjes's experiments, Pfluger places the source of glycosuria in the white gangrene resulting from the cauterizing and which is undoubtedly a violent irritant to the nerves. Pfluger's own colleague, Wetzee, never found glycosuria to result after partial extirpation of the pancreas in dogs except in the case of one female which was suffering from acute peritonitis.

Pawlow has shown that the pancreas is innervated by the vagus. D. Kulz claims that stimulation of the central end of the cut vagus leads to glycosuria. E. Cavazzani's work tends to show that stimulation of the celiac plexus causes sugar by synthesis in the liver. The number of ways in which nerve stimulation may affect the metabolism of the carbohydrates is many. Claude Bernard maintains that the puncture of the floor of the fourth ventricle in the rabbit is followed by a transitory form of diabetes, the so-called Pique diabetes. This is known as the diabetes area. Pfluger says, "It is hardly to be doubted that there is a complicated nervous mechanism regulating the sugar metabolism much in the same way as the heart is regulated by a complete nervous system." Minkowski finds that in dogs and other mammals complete extirpation leads to the severest forms of diabetes mellitus. In other animals he found the same to be true which has been verifled by nearly all workers on this problem.

Pfluger, in experimenting on frogs, produced diabetes after removal of the pancreas in all but one case. He says that failure to obtain glycosuria after total extirpation is due to the blood supply of the liver being very

intimately connected with the pancreas and hence it is difficult to remove all without injuring the liver. If such a relation between the liver and the pancreas exists, and we find nothing in the literature which questions it, these two organs as well as the stomach and duodenum should bear a certain functional relationship with one another. Marius got diabetes in twelve frogs out of nineteen experimented upon. Gaupt also believes that the negative glycosuria in frogs upon removal of the pancreas, as reported by Minkowski, is due to its intimate connection with the liver.

Pfluger, in one paper, advanced the theory that two antagonistic powers regulate the sugar content of the urine. One is the function of the nervous system and has its center in the medulla. This power may cause a rise in the sugar content of the urine. The storing of glycogen in the liver depends partly upon this center. From all parts of the organism centripetal nerves pass to this center so as to regulate the needs of the organ.

The other force is a chemical or anti-diabetic force of a substance secreted in the pancreas. By some unknown force it hinders the formation of sugar in the blood. Bernard and Eckhard have determined that the sugar center for metabolism lies in the medulla and works through the splanchnic area on the production of sugar from glycogen. As long as any part of the pancreas is alive it must have a central nervous connection by means of the fine net work of nerves along the blood vessels supplying blood to the pancreas.

There seems to be sufficient reason for accepting this nervous mechanism by way of the splanchnics, but whether they are secretory, trophic, regulatory, or perform their function by regulating the blood supply has not been determined. Pfluger argues that the pancreas has a direct connection with the sugar center and consequently with the liver and duodenum. Evidently the glandular substance must play some important part in the sugar metabolism as diabetes results immediately on the removal of the last small part which previously had prevented the diabetes. In this way the excessive formation of sugar is counter-

acted by the action of the secretion of the pancreas to form an anti-diabetic ferment.

Partial extirpation, that is, from the head or tail of the gland, leaving from one-third to one-fifth of the organ gives the foregoing results, but the quantity of gland remaining is not as necessary as its state of nutrition, blood supply and innervation. Minkowski found glycosuria to be very slight in one case where he had left a part of the gland the size of a pea. In this case on feeding protein the sugar disappeared in the urine but reappeared on carbohydrate diet. Minkowski and Sandmeyer have observed cases of incomplete extirpation in which a slight glycosuria appeared which gradually reinforced itself and grew to a severe case of diabetes. This evolution comes about from a degeneration of the glandular elements after atrophy of the fragments of the gland remaining from the partial extirpation. According to Minkowski partial extirpation gives three results, viz: First, absence of diabetes; second, diabetes of a light form; third, a light form of diabetes which gradually becomes severe. It would seem, and in fact, it is stated by some of the most experienced workers, that it is the interference with the blood and nerve supply and not the lack of glandular tissue which causes the glycosuria in partial extirpation.

Relation of Pancreas and Liver: According to Cheveau and Kaufman the pancreas is coupled with the liver in relation to glycogen formation. The formation of sugar from glycogen is increased after extirpation of the pancreas, and the amount of sugar used by the body remains the same. The sugar content of the blood is the same before or after the animals have been rendered diabetic. Section of the cord below the bulb whether alone or combined with extirpation of the pancreas causes diabetes, and, according to Cheveau and Kaufman, there are two centers in the bulb influencing the formation of sugar from glycogen. These two centers are acted on by the internal secretion of the pancreas in an opposite way. The inhibitory center is excited and the excitatory center is inhibited. The extirpation of the pancreas destroys the action of the inhibitory

center and activates the excitatory center, thus causing the formation of sugar from the glycogen.

The internal secretion exercises a powerful retarding action on the disintegration of the tissues. Overproduction of sugar from the liver is the cause of pancreatic diabetes. First, from a disturbance of the nervous mechanism regulating the hepatic-glucose formation; second, by direct action on the liver, (suppression or a moderating action which produces the internal secretion of the pancreas which acts directly on the hepatic-glucose formation), and third, from histological disintegration, a larger amount of that material passes into circulation which is apt to form sugar in passing through the liver, i. e., a suppression of the moderating action of the pancreas on that substance.

Cutting the vagi and splanchnics has been found by Von Graefe and V. Henson to produce temporary glycosuria. The same kind of glycosuria is obtained by cutting the lower cervical ganglion. In four or five hours a maximum diabetes is reached. Traces may be found for even twenty-four hours. Eckhard obtained slight glycosuria upon cutting the upper chest ganglion of a sympathetic nerve. Emil Canazzani has done some interesting experiments upon the celiac plexus. He stimulated the nerves to the liver, electrically, and obtained a decrease in the amount of glycogen in a few moments and an inverse in sugar content. Two dogs were experimented upon, the stimulation being kept up for from five to fifteen minutes. In the first dog the glycogen was 1.67%, and after stimulation was .77%. The other dog showed 3.94% before, and 2.30% after stimulation. How does this affect the formation of anti-bodies in the pancreas?

If the vagus is stimulated in the neck the stomach and oesophagus contract while the peristalsis of the intestine is apparently not affected, yet we know the vagus exerts a power over the intestines. Many have stimulated and obtained no secretion of the pancreas or stomach, yet Powlow has conclusively proven that. So far it has been contended that the plexus of the duodenum controls the secretion of anti-bodies in the pancreas.

Now it is to be proved that the duodenum does not

have an internal secretion which helps to form the anti-bodies. Hedon grafted a piece of pancreas in a dog. This piece was connected with the peritoneum through nerves and blood vessels, then the entire pancreas was removed. Later the connection with the mesenteric nerves and blood vessels was cut and no diabetes resulted, hence the duodenum cannot form anti-bodies and does not influence the pancreas only when there is a nervous connection. This is of no immediate value to us in presenting the argument set forth in this article other than to show the nervous relation existing between the duodenum and pancreas.

Transplantation: Hedon transplanted part of the pancreas under the skin and then removed the remaining pancreas. In this case no diabetes resulted, but when the grafted portion was removed diabetes immediately became evident and sugar was found in the urine.

He says that the few cases in which the above is not the result can be attributed to the outgrowth of the grafted pancreas upon the wall of the abdomen and the failure to remove this outgrowth. Sbolew, Minkowski, Thiraloix, Pfluger and others, by similar experiments have partially confirmed these results.

Feeding or injection of pancreatic extract: If the pancreas produces a substance which aids sugar metabolism it would seem possible and necessary in order to prove this secretion, to obtain from the extirpated pancreas a substance which upon injection into a diabetic animal would prevent the excretion of glucose in the urine. In 260 cases performed by Hedon there have been few results on injection of this pancreatic extract. Capparelli, however, with the same procedure, found that the sugar excretion was lessened in three hours and in most cases it completely disappeared. But Pfluger contends that in his experiments there seems to be some doubt as to whether he had removed all the pancreas. Experiments by many prove that feeding the pancreas of cattle increases the sugar from three to four times the normal amount.

Other methods of causing Glycosuria: Minkowski says that sugar elimination may be caused first by eating much sugar, (alimentary glycosuria), that is, flooding the

organism with it; second, by rapid changing of glycogen into sugar by the liver causing an increase in the blood and consequently sugar in the urine, and third, by the administration of certain drugs. In pancreatic extirpation the oxidation of sugar is disturbed, while the drug causes sugar elimination without disturbing oxidation of the sugar. It causes the kidneys to take the sugar from the blood and secrete it, thus causing the percentage of sugar in the blood to fall below normal. It is thus shown that increased elimination of sugar in the urine can be caused in other ways than by disturbance of the function of the pancreas. It would seem from this that any interference with the innervation or nerve supply to the pancreas liver or duodenum might effect at least a low percentage of glycosuria.

Proofs of Internal Secretion: As long as there is no other proof at hand than that which has been advanced so far, the theory of internal secretion must stand. Hedon has taken the sterilized extract of pancreas and injected it in large doses intraperitoneally and intravenously, without checking the diabetes. He found that the injection of water or glycerin extract of pancreas intraperitoneally always produced a large amount of pus even though the greatest care was exercised. If the extract was filtered through a medicated candle, hard knots appeared in place of abcess and these were gradually absorbed. Hedon thinks the candle removes the protein enzymes. After this filtration large amounts may be injected intravenously without killing the animal. Pfluger tries to disprove the theory of Minkowski, that pancreatotomy retains the toxins of the liver, by transfusion of blood from a diabetic animal to a healthy one without producing glycosuria in the healthy dog.

Chemical Stimulation: Diabetes may be produced by chemical means. Certain substances, such as phloridzin and uranium salts are capable of producing a severe glycosuria which has been thought to be due to the detrimental action of these substances on the kidney cells. Coincident with this type of glycosuria there is a diminished sugar content in the blood. Various other substances such as carbon dioxide, adrenalin, ether, chloroform, morphine,

curare, veratria, pyrogallol, salicylatis, pilocarpine, amyl-nitrate, and potassium cyanide, possess the property of inducing glycosuria, and as far as has been investigated, according to Underhill, an accompanying hypoglycemia has been noted. Obviously, he says, this type conforms more closely to the true diabetes. Harter has shown that glycosuria is usually readily produced by painting the pancreas with piperidin or by intraperitoneal injection. At times this sugar elimination is very marked and may persist for several hours. Again the glycosuria is very slight or may be entirely lacking even though large doses of the drug have been given. Piperidin was selected by Harter as he thought it a typical representative of a number of drugs which produced glycosuria. In the case of piperidin glycosuria as studied by Harter two attempts were made to determine whether it was accompanied by hyperglycemia. In neither of these experiments was the sugar content of the blood changed, and the suggestion was made that the renal factor is associated with this form of glycosuria. These experiments have been repeated by Underhill and the influence of piperidin applied to the pancreas with the following results: In three experiments by painting the pancreas with 5 c. c. of 4% piperidin he got only an average increase of .07% of sugar in the blood. This appears contrary to Harter's results mentioned above, but not so much of an increase when we recall that probably .04% of this amount obtained might have been due only to the anesthesia, leaving possibly .03% actually produced by the painting of the piperidin. These results also present variations of as much as .09% and no two of them check closer than .03% so that the inaccuracy of such results is plainly evident. In reviewing the tables of experiments performed by Underhill, Scott and others, we find that in many cases the glycosuria is lacking. This may be explained by the fact that small or insufficient doses of the drug were given, and hence the increase in sugar content of the blood was not sufficient to cause elimination by the kidneys. Hedon, Gley and Thiraloix have caused a profound degeneration and atrophy of the pancreas by injection of various substances without causing a trace of diabetes. Advocates

of the internal secretion theory maintain that under the foregoing conditions small portions of the pancreas probably escaped degeneration. On the other hand adherents to the nervous theory fail to conceive how microscopic remnants could so thoroughly regulate sugar metabolism.

Relation of the Islets of Langerhans and Zymogenous Tubules in the Pancreas. After inanition, in some animals at least, it has been shown by Statkewitsch that there is a material increase in islet tissue. This statement has been confirmed by Vincent and Thompson, and also by Dale. There are rows of epithelial cells separated by very large expanded capillaries as in the thyroids. They thus present a very large surface in the blood stream. Between these rows of cells can be differentiated at times very fine granular substances which are afterwards extruded into the lumen.

From the above it will be seen that much work has been done in an attempt to determine the various causes of glycosuria and hyperglycemia. The results of these workers are so much at variance that it is indeed difficult to arrive at any definite conclusion. That the nervous system has at least a regulatory influence upon carbohydrate metabolism seems to be conclusively settled. That the blood supply to the pancreas also plays an important part seems quite probable in that it effects a greater or lesser functional activity by the quantity supplied, and by association of various organs through internal secretions. That the pancreas produces an internal secretion which is essential to carbohydrate metabolism has also been established.

Relation of Thoracic Bony Lesions to Carbohydrate Metabolism.

It has been our purpose in this series of experiments to determine the relation of thoracic bony lesions on similar functions. Drs. McConnell and Farmer have done work on the relation of spinal lesions to functional disorders. They have found that spinal lesions in some cases, at least, are accompanied by glycosuria, but the greater part of their work has been along other lines. So far as we know, nothing has been done with this one purpose in view.

From the osteopathic texts we find the following: "I have found variations from the normal generally beginning with the ninth dorsal. I carefully examine and adjust every section of spine to the sacrum and coccyx, also the eleventh and twelfth ribs on both sides. These variations act powerfully on the excretory system and excite and irritate the solar plexus which gives off branches to the abdominal excretory system."—Page 401 Osteopathy, Research and Practice, by Dr. A. T. Still. "Almost invariably there will be found a posterior dorso-lumbar curvature where in the spinal column tissues are much contracted. This condition probably involves the sympathetics (vaso-motor and trophic), to the pancreas, liver and intestines."—Practice of Osteopathy, McConnell and Teall.

It would seem logical that if the bony lesion produces functional errors in the cord or splanchnic fibres, either or both, that these disturbances should interfere with the nervous mechanism which, as has been pointed out above, regulates certain functional activities governing carbohydrate metabolism, errors of which bring about certain functional disturbances such as glycosuria and hypoglycemia. That spinal bony lesions produce marked variations in blood pressure has already been demonstrated in our mammalian experiments, Series No. 2.

The results of continued lesions on blood pressure have not as yet been determined by experiment, but judging from the results of the work that has been done, we find that lesion in, or pressure on, the middle dorsal produces an increase in blood pressure by vaso-constriction. Now we know that over-stimulation results finally in inhibition, which would mean vaso-dilation and an increase in blood supply to the part innervated by the nerves from this region of the spine. This would mean a greater amount of blood than the veins could normally carry away, and therefore a congestion of the parts which in turn would mean a temporary increase, followed by a decrease, in function. We know that the functional activity of most secreting glands varies directly with their blood supply.

The ability of the gland to produce internal secretion normal in quantity and quality should also be affected by

any interference with its nerve or blood supply. Therefore, considering that the pancreas produces an internal secretion which performs an important function on carbohydrate metabolism, this would be materially affected by the spinal bony lesion if our reasoning is correct.

Experimental methods employed: Many things were to be considered in the study of functional effects. The normalization or the selection of normal animals is always first for obvious reasons. Dogs were the animals used because they may be more easily managed and will furnish sufficient urine for examination. Healthy dogs of medium age were used, as these are more likely to be normal. Each dog was kept from one to four weeks before being caged. It was usually necessary to feed the dogs regularly for a time to get them in good condition and accustomed to the new environment. If, after this preliminary test, the dogs seemed normal they were then placed in a cage and their physical condition was more carefully studied.

This cage, built of iron bars, was thirty inches wide, thirty high and eighty long. Each cage was divided into two compartments separated by a sheet iron partition and stood twelve inches from the floor. The floor of the cage consisted of heavy screen wire resting upon iron bars, which allowed the urine to pass through and be immediately separated from the feces or other material from the dog's body. Beneath the screen floor a zinc pan was suspended which served to collect the urine and drain it into another container. The door of the cage consisted of one entire end hinged in such a way that it might be removed. All parts of the cage were made so that they might be removed for cleaning and sterilizing. These cages were painted that they might be more easily cleaned and to prevent iron rust contamination in the feces and other material to be examined. The cages were washed clean with hot water and brush and sterilized with boiling water and steam twice daily. The containers used for collection of urine were cleaned and sterilized at the same time. Six such cages were used accommodating twelve animals at a time.

Care of the Animals: After the animals selected had been kept long enough to determine that they were in

good physical condition, they were given a soap bath in warm water and thorough scrubbing with a brush followed with a cold shower, and placed in the cages for normalization. Samples of urine were then taken twice daily and qualitative and quantitative analysis made.

Normalization of dogs: After being thoroughly washed, each dog was carefully weighed, (a special pair of scales being used which were sensitive to 25 grams), and placed in a separate cage and left for from eight to twelve hours, after which time the nature and consistency of the feces were noted and the urine tested. The dog was fed and watered and given exercise by allowing it to run about on the campus, or when the weather was too bad they were allowed to run free in the room. The cages were again cleaned and sterilized with boiling water and steam and the feet of the dogs washed before returning to the cage. Once or twice each week the dog received a soap scrubbing and shower bath. A regular mixed diet was given twice daily, the amount of food and water taken each day being noted. If the dog after being kept under such circumstances for a period of from two to four weeks showed no abnormal symptoms, and its urine was free from sugar, and was otherwise normal, and if the dog gradually increased or remained constant weight(dogs will usually show a constant increase in weight when kept under such conditions), it was considered normal and ready to be tested. Before lesioning, each animal was etherized usually two or three times to determine the effects of the anesthetic on the functional activities of the dog, and particularly its relation to production of sugar in the urine. Many animals show a slight glycosuria, from .03% to .1% after administration of ether. The animal was then left for a few days longer and, if no abnormal symptoms developed, was lesioned.

Methods of producing bony lesion: The dogs, after normalization, were placed under complete ether anesthesia which was maintained until the lesion was produced. Traction to the spine was first applied by pulling upon the caudal end while the anterior part of the body was held. After stretching, the lesion in the thoracic region (mid and

lower dorsal), was produced by rotation with fixation, one individual holding the vertebra by pressure on its spinous or transverse process while another rotated the caudal end of the animal. As soon as a marked subluxation could be palpated the animal was released and placed in a normal position and the vertebra again palpated. It is no easy task to produce a permanent bony lesion in a healthy dog, as they often adjust themselves while coming out of the anesthesia, or within a few hours after the operation. Often the same lesion must be produced from three to six times before it remains and in a few dogs we were never sure that we got a permanent bony lesion. This fact in itself, however, is no argument against the existence of the bony lesion in man, because of the anatomical differences between the dog's spine and the human. The dog's spine is so different in many respects that it is necessary to make a careful study of its particular anatomy before any tests may be successfully tried.

Care of Dogs after Lesioning: After lesioning, the animals were placed in their cages and watched until they had recovered from the anesthesia. The care after lesioning was the same as given above under "Normalization," except that they were not exercised for a day or two after the lesion was produced. This was done to prevent accidental correction of the lesion from vigorous exercise. Two rooms were used for the dogs both of which were supplied with steam heat which could be well regulated, hot and cold water and steam for sterilization and good ventilation. The floors were scrubbed every day and everything kept in a sanitary condition to maintain good environmental conditions. One room was kept for the cages, the other for a "playroom" where the animals could take regular exercise. During spare time twenty students were kept busy for a period of thirteen months caring for these animals, analyzing the urine, etc. Only two dogs were given to one student at a time. A daily record of the general condition of every animal was kept in a ledger as follows: Weight, diet, amount of food and drink, nature of feces, etc., to which was added the urinary findings.

Examination of Urine: The urine free from feces

and other contamination was collected twice daily and kept in a cool place until ready for analysis. Each sample was then measured and placed in a clean beaker and the following test made.

1. Any cloud present was tested for mucin, phosphates, urates, pus and bacteria.

2. The color was recorded according to Vogel's color scale.

3. The specific gravity was taken by means of a urinometer and test jar.

4. The amount of solids was estimated by use of Haesser's co-efficient. (2.33).

5. The chemical reaction was taken with litmus paper. When alkaline, the cause of the alkalinity was determined as due to fixed (sodium and potassium) or volatile (ammonia) alkalies.

6. The quantity stated is for each twenty-four hours unless otherwise specified.

7. The amount of urea was determined by means of a Hinds-Doremus ureometer and a solution of sodium hypobromite. In some instances (animals Nos. 10 and 11) the determination was made by means of a Hufner apparatus. The hypobromite solution used was prepared fresh each day.

8. Albumin tests were made by means of Heller's nitric acid test, the acetic acid and heat test. Any traces showing by these methods were confirmed by means of Esbach's solution. Picric acid, 10 grams, citric acid, 20 grams and sufficient water to make 1,000 c. c.) Quantitative tests were also made by the Esbach twenty-four hour method.

9. In the estimation of chlorides a standard 12½% solution of silver nitrate was used.

10. Phosphates were determined by means of magnesium mixture.

11. Sugar tests were made by means of, first, Haines' or Fehling's solution, second, by Nylander's reagent, and third, by Benedict's reagent. Quantitative tests were made by first, Fehling's solution, and second, by Einhorn's saccharometer, (fermentation test). In no case was sugar reported present unless confirmed by two or more reduction tests and a fermentation test. On dogs constantly showing sugar, acetone tests were made at various intervals by, first, Legal's test; second, Lieben's test (after distillation with phosphoric acid.) All fermentation tests were controlled by means of a distilled water tube and a 1% glucose solution tube.

12. Indican tests were made by means of Obermeyer's reagent, (.3% Fe^2Cl^6 in HCL), and extraction by chloroform, the urine having been previously decolorized by lead acetate. Tests were checked by the HNO^3 and HCL test);

13. Blood tests were made by means of old turpentine and tincture of guiacum (Haines' blood test);

14. Tests for uric acid and urates were made by:
    (a) The difference of solubility of urates in cold and warm solutions;
    (b) By means of the Murexide test.

All tests were checked by water controls and the beakers, glassware and apparatus were washed each time in hot water, alcohol and ether and kept in a dust proof locker. Test tubes used for sugar tests were kept separate and cleaned in nitric acid to remove any precipitate of copper oxide and thus eliminate any fallacious reductions. The urinometers used for taking specific gravity were tested frequently with distilled water to establish their accuracy. All urine used in the various tests was carefully filtered, and in the sugar reduction tests any albumin present was removed by boiling and filtration. Dr. E. H. Henry, professor of Chemistry and Clinical Diagnosis, superintended this part of the work.

To insure that no personal factor might affect the results, those who analyzed the samples of urine were not allowed to know anything regarding the nature of the animals tested. They never knew whether the samples came from normal or lesioned animals and were seldom even allowed to enter the room in which the dogs were kept. More than two thousand complete qualitative and quantitative analyses were made according to the methods given above during the series.

Post mortem examination: After a permanent lesion had been produced, the dogs were kept from two weeks to seven months under the above-described condition. After a good record had been obtained the dogs were killed by the use of chloroform and placed immediately upon the operating table, ventrum down. The skin was laid open the entire length of the spine and laid back. The superficial appearance of muscles and fascia was carefully

inspected in the presence of other members of the faculty. The entire spine was then removed, the ribs being clipped off two or three inches from the spine which was then examined as to its general contour, curvatures, specific subluxation, etc. In some cases deep dissections were made, but usually it was placed immediately into fixing solution and given to a pathologist, together with specimens of the viscera for pathological examination. This part of the work has not as yet been completed, and therefore we cannot report on the findings at this time.

It has been suggested that such lesions as we claim to produce experimentally could either not be produced and made to remain as permanent subluxations, or they would be complete luxations in which case there would be trauma to the cord and the effects would be produced in this way. That permanent subluxations can be produced experimentally on animals has been conclusively proved by the work of Drs. McConnell and Farmer and verified by the results of this series of experiments. That these lesions were not luxations which could cause any trauma to the cord is evident from the many post mortem examinations which have been made by Drs. McConnell and Farmer and by the work reported in this article. That the subluxations which we have produced do not produce their effects by pressure or trauma to the cord is evidenced by the fact that none of our lesioned animals have ever developed the slightest paralysis or other symptoms of trauma to the cord.

Results: We give here a brief history of every animal used lest we be accused of selecting special examples.

Animal No. 1. This was a well nourished female about three years of age. The weight was about 15 kilograms. (In the beginning, we had no balances for weighing, therefore no exact account of nutrition can be given.) There were no signs of recent pregnancy, and the spine was normal.

Normalization: With proper feeding and good care the animal increased in weight and improved in general nutrition. Appetite was good and feces normal.

Urinary findings: Showed an average of .028% sugar in urine for ten days and no sample went above .2%

After lesion, rotation in lower dorsal. Twenty-four hours after lesion the urine showed .1% sugar, with a

slight increase in specific gravity. On the second day the animal showed a presence of 2.78%. There was tenderness at that point of the spine where the lesion was produced, but no other symptoms except a slight diarrhœa on the second day after lesioning. No post mortem was made.

Animal No. 2. A female with no signs of pregnancy, about four years old. Weight, 11,300 grams, with excellent nutrition and general good health.

Normalization: This animal was kept for three weeks before caged. While caged she showed only a very slight trace of sugar once in thirty-three days and no other abnormalities.

After lesion, rotation in lower dorsal. The following day the animal showed .1% of sugar in urine and for twenty-six days following the urine varied in its sugar content from a trace to .5% showing an average of .11% during this time. The lesion was lost and reproduced. (During this time there was a gradual increase in weight up to 12,000 grms., showing no loss in nutrition.) There was an average increase in specific gravity from 1.030 to 1.039, and a decrease in amount voided. The daily voidance while normal was 224 c. c. and after lesion only 110. There was an increase in solids of .5 gms. per 100 c. c. but no other material changes. The animal now seemed to be recovering from the effects of the lesion, during the next twenty-two days there being only an occasional trace of sugar in the urine. The quantity was increased to an average of 120 c. c. for twenty-four hours. A slight increase in indican was evident. Specific gravity showed an average of 1.037 and the solids were increased 1 gm. per 100 c. c. above the normal. The weight of the animal remained about constant with daily variations. No decrease in nutrition or appetite, and no material changes in the consistency of the feces was observed. During the third month the sugar in the urine reappeared, varying from a trace to .5% . The specific gravity increased to an average of 1.042 and the weight of the animal remained constant. The solids constantly increased from 8 to 9 gms. per 100 c. c., indican increased, and quantity increased to an average of 155 c. c. daily. Urea was markedly decreased. The feces remained normal in consistency. From this date, February 26th, up to the present date, May 25th, the animal's urine continued to increase in sugar content, averaging from .25% to 1.% daily, specific gravity 1.038, and quantity 124 c. c. with an increase of urea and indican; the weight still remained about constant, and no abnormal consistency of feces. This animal has now shown functional disturbances for nearly

seven months after the last lesion was produced. It is to be kept under observation for a few months longer.

Animal No. 3. After eighteen days of observation this animal failed to normalize. It was discarded.

Animal No. 4. This was a female about eight years old, weighing 10,300 gms. General condition and nutrition was fair.

Normalization: This dog showed only a slight increase in weight during normalization, but this may have been due to the age of the animal. The dog was normalized for thirty-two days, during which time on three different days traces of sugar were noted.

Urinary findings: Average specific gravity was 1.033, with an average voidance of 80 c. c. daily. Urea 1.5 gms. per 100 c. c.

After lesion, rotation in lower dorsal: This dog was observed twelve days after the lesion was produced. There was an occasional glycosuria amounting to .25%. The specific gravity increased to 1.041. The quantity for twenty-four hours decreased from 80 to 52 c. c. daily average. The urea was increased to 3.3 grams per 100 c. c. On third day after lesioning, the animal became so ill that it had to be removed from the cage. The appetite was lost, and constipation developed, the feces being very hard and dry. The weight decreased to 8,040 gms., and the animal became very weak.

Post mortem: The lesion was found to be a rotation subluxation between the tenth and eleventh thoracics. The spine was kept for pathological examination. The extreme effects resulting in this instance might be attributed to the age of the dog. Young dogs are not so easily affected.

Animal No. 5. A female of about five years, weighing 13,000 gms., with general good health and nutrition.

Normalization: The animal was normalized for twenty-six days, during which time it showed a trace of sugar in the urine.

Urinary findings: Specific gravity was 1.034, and the quantity voided 139 c. c. with a presence of .5% urea.

After lesion, rotation in lower thoracic region: During the following fourteen days there was a slight increase in sugar in the urine. The specific gravity fell to 1.028, and the average daily quantity was 128 c. c., urea, 1.8%. There was a slight diarrhoea on the second day but no other symptoms. The lesion disappeared on the third day, and the dog was relesioned on the fourteenth day after the first lesion with the following results: There was a slight increase in glycosuria, specific gravity being increased to

1.035, urea 3.7%. The quantity fell to 106 c. c. The dog escaped one week after the second lesion was produced and no further results were obtained.

Animal No. 6. A young bitch about two years old, and seemingly in perfect condition, but showed an almost constant glycosuria and other abnormal urinary contents for three months. The animal was never lesioned.

Animal No. 7. This was a male dog about two years old in perfect condition, nutrition, appetite, etc., being excellent.

Normalization: This animal was kept thirty days under optimum conditions during which time there was only a slight trace of sugar in the urine.

Urinary findings: Specific gravity was 1.039 with an average voidance of 338 c. c. Urea, .87%. There were no abnormal findings. The feces were normal and the animal increased in weight from 16,000 gms. to 17,225 gms.

After lesion, in lower throacic region: The animal showed a glycosuria varying from a trace up to .5% showing an average of .2% for the first month, .3% for the second month, .2% during the third month, and .6% during the fourth month. The specific gravity for the first month after lesion was increased from 1.021, to 1.023, 1.024 for the second, 1.032 for the third, and 1.033 for the fourth month. The quantity was diminished from 338 c. c. daily normal to 228 c. c. for the first, 254 c. c. for the second, 225 c. c. for the third, and 223 c. c. for the fourth month after lesion. The urea showed an increase from .87% normal to 1.8% for the first, 1.6% for the second and 2.3% for the third month with a decrease in the fourth, the average after lesion being 1.5 gms, per 100 c. c. The weight continued to increase for two months after the lesion was produced, reaching a maximum of 22,100 gms. The weight then began to decrease and at the end of the fourth month had fallen to 20,000 grams, with a marked change in general health and nutrition. The appetite was not as good as during the last month, but this might have been due to insufficient exercise. The feces were occasionally abnormal, but no marked diarrhoea or constipation occurred.

Post mortem: Dissection showed a lesion between the ninth and tenth thoracics and an approximation between the second and third lumbar segments. The lower dorsal region showed a scoliosis with convexity to the right. The spine was kept for pathological examination.

Animal No. 8. This dog was tested for twenty-one days, but could not be well normalized, and was therefore not used.

Animal No. 9. This was a female about five years old, weighing 11,400 grams, and seemingly normal in every way.

Normalization: This animal gradually increased in weight during the sixteen days of normalization; nutrition, appetite, feces and general condition normal.

Urinary findings: There was only a slight trace of sugar in the urine during normalization. The specific gravity was 1.036 with a daily voidance of 121 c. c., urea 1.1%.

After lesion, in the mid-dorsal: The animal gradually decreased in weight from 12,000 to 10,000 grams after two months. The dog's appetite increased some, and she was not as lively, but this of course might have been due to insufficient exercise. The dog also showed varying abnormalities in feces, sometimes hard and dry, at other times a slight diarrhoea appeared. No glycosuria except occasional traces appeared for thirty days after the lesion. From this time on for forty-seven days there was a glycosuria varying on different days from a trace to .5%, an average of .33%. For three days following the lesion, the specific gravity was 1.039. Quantity increased to 135 c. c. daily, and urea 2.9%, or an increase of 1.8 grams per 100 c. c. The dog was then allowed to run free for thirty days, and again caged. After being caged it was kept for forty-seven days. The average specific gravity was 1.028, the quantity 150 c. c. daily and 2.9% of urea. There was very little variation except in the sugar content, but a marked increase in indican.

Post mortem: This dog was accidently killed, and therefore no examination of the spine was made.

Animal No. 10. A female of about four years, weighing 12,000 grams. Physical condition and general health was good.

Normalization: The animal was normalized for twelve days, during which time the weight gradually increased, nutrition, appetite and feces remaining normal.

Urinary findings: Showed a trace of sugar on one day only. Average specific gravity of the urine 1.025, quantity 331 c. c. and 3.6 grams of urea per 100 c. c.

After lesion, in the mid-thoracic region: There was a decrease in weight from 12,000 to 11,000 grams. The nutrition was not good and appetite decreased, many days the dog refusing food. There was a constant diarrhoea for thirty-seven days, and a mucopurulent discharge from the vagina. Bacteriological examination showed a pyogenic infection. Urinary analysis showed a slight glycosuria varying from a trace up to .25%. The specific gravity was 1.029 and the quantity reduced to an average of 150 c. c.

with an increase in urea to 2.4 grams per 100 c. c. An increase in indican was noted. Dog now began to improve, and we think the lesion had been accidentally corrected as it was no longer palpable. The dog was then allowed to renormalize for forty-two days, during which time the weight gradually increased to 16,700 grams. Nutrition and appetite were good. The feces were normal, and the discharge from the vagina had stopped, so that physically the animal was in perfect condition.

Urinary findings during the normalization: The sugar in the urine materially lessened. Specific gravity decreased to 1.027, but the quantity increased to 370 c. c. daily voidance, the urea decreasing to .1 grams per 100 c. c. The indican was much reduced.

Results of the second lesion: The lesion was reproduced in the same region and manner as before, with the following results: There were no abnormal symptoms during the ten days following the lesion. The specific gravity was 1.031, quantity 336 c. c., and urea 2.5%, with no glycosuria. Upon palpation, no lesion could be found. We therefore decided there has been another accidental correction, so the animal was lesioned a third and a fourth time. No permanent subluxation could be produced. The dog remained in normal condition physically. There were no abnormal urinary findings except an occasional appearance of albumin and indican. The urine remained turbid for two months, but no glycosuria appeared.

Post mortem: A marked scoliosis was found in the lower thoracic region, but there were no specific subluxations.

Animal No. 11. A male about four years old, weighing 13,000 gms, and in good physical condition.

Normalization: The animal gradually increased to 13,500 gms. in fifteen days, during which time the nutrition, appetite and feces were normal.

Urinary findings: A trace of sugar appeared on the first day only. Specific gravity was 1.041 with an average daily quantity of 289 c. c. and 2.5 gms. urea.

Results of lesion, produced in lower dorsal: Animal continued to increase in weight during the following sixteen days. The appetite, diet and feces were normal with an exception of a slight diarrhoea on the third and fourth days following lesion. There was a slight glycosuria amounting to .25%, but was not of constant occurrence. Specific gravity decreased to 1.035, the quantity decreased to 212 c. c. daily voidance while the urea was slightly increased. The animal was allowed to run free for twelve

days that it might be under more natural environment. It did not seem to be as lively, but continued to increase in weight. It was then caged again and kept for fifty days. During this time the weight increased, the appetite was good, but there was an occasional diarrhoea and on the twentieth day it began to vomit and showed other signs of stomach and intestinal irritation.

Urinary findings during this time: There was a slight glycosuria amounting to .25% occurring about every fourth day. The specific gravity of the urine was 1.033, quantity 187 c. c. daily voidance, with 2.7 gms. urea, and a marked increase in indican.

We think the lesion was accidentally corrected about this time as it could no longer be palpated. The animal was then allowed to run free for twelve days and was relesioned, this time in the cervical region, (first or second.) There was no physical changes following this, and no glycosuria occurred. Specific gravity was increased to 1.038, and the quantity had risen to 212 c. c., urea 2.6 gms., with only an occasional trace of indican. The animal was again lesioned, rotation between the ninth, and tenth thoracics. Weight during the following thirty-two days remained about constant. There was an occasional trace of sugar in the urine. The specific gravity was 1.041. Quantity 213 c. c. with 2.6 gms. urea per 100 c. c.

Post mortem: Examination showed a marked rotation of the tenth thoracic with a lateral curvature.

Animal No. 12. This animal did not normalize well, and therefore was not lesioned.

Animal No. 13. This dog was a male in good condition in every respect, about five years of age.

Normalization: The weight continued to increase from 16,200 to 16,600 grams during the twelve days of normalization, appetite and feces remaining normal.

Urinary findings: There was no sugar in the urine. The specific gravity was 1.027, average daily quantity 249 c. c. with 1.7 grams of urea.

After lesion, rotation in the lower dorsal region: The animal was observed for thirty-two days. The weight remained about constant with daily variations; the appetite and feces remained normal. There was a constant glycosuria, averaging about .25% during the entire time. The specific gravity was 1.024, quantity 304 c. c., with 1.7 grams of urea. There was an increase in indican and albumin.

Post mortem: Dissection showed a marked rotation of the tenth thoracic vertebræ with much discoloration and congestion of the adjacent tissues.

Animal No. 14. This was a male weighing 9,425 grams with poor nutrition but rapidly increased under good care. The appetite became good and the feces normal.

Normalization: This animal was given good care for two weeks, and then caged for twelve days, during which time it improved physically, and increased in weight.

Urinary findings: The urine showed no sugar. Its specific gravity was 1.034 and average quantity was 112 c. c., with 2 grams of urea. There was an occasional trace of indican but no other abnormal findings.

After lesion, rotation in lower thoracic: This dog was carefully observed for sixty-one days. There was a constant increase in weight from 9.425 grams to 12,000 grams. The appetite remained good and feces normal with the exception of an occasional slight diarrhoea. There was a constant glycosuria which began on the day following the lesion. It increased from a trace to .25% on the thirteenth day. From this time on it varied from a trace up to 5% and continued until the dog was killed. The average specific gravity was 1.039, the quantity of daily voidance 168 c. c. with 2.7 urea.

Post mortem: Dissection showed a rotation of the tenth thoracic vertebræ. The spine was kept for pathological examination.

Animal No. 15. This was a female about seven years old, seemingly in good physical condition, but constantly showed glycosuria.

Post mortem: Examination showed a curvature in the dorsal region. The spine was kept for pathological examination.

Animal No. 16. This animal was a male in good condition, weighing 17,155 grams. The nutrition and appetite were good. Normal feces.

Normalization: The animal was kept for two weeks and then caged for eighteen days during which time the weight remained constant. Good appetite and normal feces.

Urinary findings: Showed only an occasional trace of sugar. Specific gravity was 1.027. Daily voidance 195 c. c., with 2.2% urea. No other abnormal findings. The animal was under observation for the following sixteen days.

The weight increased to 18,800 grams. Appetite was good, and feces normal. The urine showed a presence of from .1% to .5% of sugar. Specific gravity was 1.025, and the average daily quantity 213 c. c., urea 2.6%. No post mortem was made.

Animal No. 17. This animal was a male about six years old, and seemingly in good physical condition, but

constantly showed a glycosuria for six weeks and therefore was not used.

Animal No. 18. Male in excellent condition, weighing 9,800 grams. Appetite good and feces normal.

Normalization: The animal was kept in a cage for nineteen days before lesioned. Its weight increased to 10,900 grams. No abnormalities in appetite or feces.

Urinary findings: Showed only a trace of sugar on three different days. The specific gravity of the urine was 1.024, and the quantity 184 c. c., with 1.9% urea. There were no abnormal findings.

After lesion, rotation in lower dorsal: The animal's weight slightly decreased, but there were no abnormal feces and its appetite remained good. The urine showed an increase in sugar content from a trace to .25%. Specific gravity was 1.030, quantity decreased to 84 c. c. daily voidance, and there was a presence of 2.4% urea. Indican and phosphates increased, and albumin appeared after the third week. The urinary findings remained about the same for eighty-five days. This animal is still under observation.

Animal No. 19. This animal was caged for nineteen days, but would not normalize. It showed constant glycosuria and was not lesioned.

Animal No. 20. This dog was kept in a cage and carefully observed for sixty days. It showed an occasional trace of sugar in its urine, and was therefore not used.

Animal No. 21. This animal was kept in a cage for fifty-one days with the same results as the preceding animal. The dog was not lesioned.

Animal No. 22. A female weighing 10,200 grams in good condition, with good appetite. There were no abnormal feces.

Normalization: The dog was kept in a cage fifty-two days. It showed no abnormal physical condition, but there was an occasional trace of sugar in the urine.

Urinary findings: The sugar varied from a trace up to .25%, usually only a very slight trace. Specific gravity was 1.033, and the amount 102 c. c., with 2.9% urea per 100 c. c.

After lesion, in mid-thoracic region: The dog showed a slight increase in weight and no abnormal physical symptoms.

Urinary findings: After lesion glycosuria was markedly increased from .2% to .5% for forty-eight days. Specific gravity of the urine was 1.029, daily average quantity 197 c. c., with 2% urea. Phosphates, indican and

albumin were all increased. No post mortem examination was made.

Animal No. 23. This animal was tested for thirty-six days, but would not normalize. It showed a glycosuria varying from a trace to .5%, and was never lesioned.

Animal No. 24. This animal was tried for nine days, and showed a varying glycosuria, and therefore was not used.

Animal No. 25. Showed similar results to Animal No. 24, and was not used.

Animal No. 26. This dog was kept for forty-seven days, and would not normalize. It was therefore discarded.

Animal No. 27. This animal would not normalize, and was later found to be pregnant.

Animal No. 28. A female about six years old, weighing 6,250 grams, and in good condition.

Normalization: The animal was kept for twenty-nine days in a cage, during which time its weight increased to 7,725 grams. The appetite was good, and she showed no abnormal symptoms.

Urinary findings: No sugar was present. Specific gravity of the urine was 1.030. The average daily voidance was 205 c. c., with 3.4% urea, and only a trace of indican.

After lesion: The weight remained normal. The appetite was good, and no abnormal physical conditions developed.

Urinary findings after lesion: A presence of sugar from a trace up to .25%. The specific gravity increased to 1.039, but the urea was decreased. There were no other changes. The animal was kept for nine days.

Post mortem: Dissection showed a rotation of the tenth thoracic vertebra.

Animals Nos. 29, 30 and 31. These dogs would not normalize, and therefore were not lesioned.

Animal No. 32. A male dog in good condition weighing 14,000 grams. Appetite and nutrition excellent and feces normal.

Normalization: The dog was caged for fifteen days before lesioning. It increased in weight and was in good condition all this time.

Urinary findings: There was no sugar present in the urine. Specific gravity was 1.027, the average daily amount 103 c. c., with 2.5% urea.

After lesion, in lower thoracic region: The weight remained about constant. Appetite and general health was good. There were no signs of diarrhoea or constipation,

but sugar appeared almost constantly in the urine varying from .25% to .5%. The specific gravity was 1.026. The amount decreased to 104 c. c. daily, with 2 grams of urea. These functional disorders lasted for eighty-three days, when the animal was killed.

Post mortem: Dissection showed a left scoliosis in the lower thoracic region and rotation of the ninth vertebra.

Animal No. 33. This dog was a large male about two years old, weighing 22 kilograms. The appetite was avaricious, but nutrition poor. Examination of the spine showed a readily palpable lesion in the mid-dorsal region.

Normalization: This animal was kept for thirty days under the most favorable conditions, but could not be normalized. The appetite was good. The animal ate twice as much as it should have eaten, but frequently vomiting from thirty minutes to one hour after meals.

The vomitus showed the contents of the stomach to be almost wholly undigested. It would not gain in weight while in the cage or in the dog room, or while allowed to run free, and the animal showed an almost constant diarrhoea. The urine showed varying amounts of sugar. The specific gravity was high, but the quantity was low. Traces of albumin and indican were almost constant.

Post mortem: Dissection showed a slight rotation to be found between the sixth and seventh thoracic vertebræ, with some discoloration and congestion of the surrounding tissues. The spine was kept for pathological examination. The stomach was found to be distended, the contents had a foul odor and were hyperacidic. A meal consisting of meat and bread given six hours previous was found almost wholly undigested. We have no knowledge as to how this lesion was produced, but do know that it was there when we received the animal, and that the above mentioned functional disturbances seemed to result from it.

Summary and Conclusion.

The above results have been given very briefly, for space would not permit a complete description of the physical condition and urinary findings. Thirty-three animals were used in all, but only fifteen of these could be sufficiently well normalized to be used for lesioning. It is obvious that control is absolutely necessary, or the results would be valueless. In order that we might know the effects obtained were not due to the diet given, or any environmental condition, only six of the animals were kept lesioned at one time, the others remaining normal. The normal

animals therefore furnished controls against the lesioned animals. All of these animals were controlled against themselves, "normalized," and also controlled against other animals before and after lesioning. This insured that the results obtained were not due to accidental causes. There were never any functional disturbances resulting from the diet given, or from the conditions under which these animals were kept.

Each of the fifteen animals which normalized, out of the thirty-three used, showed some functional disturbances from the lesions produced. These disturbances varied from a slight abnormality in urinary findings, which probably would never have caused any serious trouble, to conditions sufficiently severe in nature to cause death. (Animal No. 4.)

Glycosuria appeared or was increased in every animal lesioned, varying in amount from a trace to 5%. That this condition was a permanent functional disturbance is shown by the fact that in animals kept from three to seven months after lesioning, the percentage of sugar either remained constant or increased in amount during the entire time, except in animals in which the lesions were accidentally corrected.

Either constipation or diarrhoea followed lesioning in eight out of the fifteen dogs used. In some cases this was only mild, but in four animals, Nos. 4, 9, 10 and 11, this was of a severe type. Gastro-intestinal disorders resulting in vomiting, etc., occurred in five animals.

A severe vaginal infection appeared in one animal (No. 10), which cleared up when the lesion was corrected. A few of the animals which would not normalize were dissected to determine if a bony lesion could be found that might explain the cause. In some cases either specific subluxations or curvatures were found. This part of the work was left to be investigated by the pathologist.

In conclusion it would seem safe to say from the above results, we believe that spinal bony lesions, particularly those in the mid and lower dorsal, bear some relation to carbohydrate metabolism and the occurrence of sugar in the urine; that there seems to be some relation between

these lesions and constipation and diarrhoea and possibly stomach and intestinal disorders. It would also seem possible that these lesions might in some way predispose to infection. We are undecided as to the effect of these (mid and lower dorsal) lesions on nutrition.

In most cases, for the first few weeks, at least, there was no loss of weight following the lesion, but in nearly all cases after being kept for from two to four months, in some instances in less time, the animal began to show trophic disturbances and loss in weight; but it would be unsafe to say with any definiteness that the loss of weight was effected by the lesion produced.

We have often been asked if we attempted any correction of these lesions that caused functional disturbances. We have not tried this as it was our purpose only to determine whether such lesions would produce functional disturbances in perfectly normal animals—and we believe they do. The results of this series have been briefly but definitely stated just as they were found. Physicians who read this report will be well able to interpret the results in each case, therefore no lengthy conclusion is necessary.

SOME SPINAL SYMPATHETIC REFLEXES

Series No. 5.

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It has been our purpose in this series of experiments to try to gather some information on certain physiological questions which seem to bear some relation to certain osteopathic principles. The work is a continuation of our first series of mammalian experiments which we hope to present more fully at some future time.

Problems: Does the sympathetic system react to the stimulation of all typical spinal and cranial sensory nerves?

Is there any special reaction for the stimulation of these nerves? If so, what is this reaction and what conditions may influence it, if not where may we expect the reaction?

Much has been learned about the spinal sympathetic reflexes from the vast amount of work that has been done on the individual organs and in the following discussion, an attempt will be made to briefly summarize some of these better known reflexes.

It is a general physiological rule that afferent impulses may either excite or inhibit the activity of a nerve center. I want to emphasize the fact that this is a general rule and does not imply any specific group of afferent fibers nor any individual so-called center. While it is true that stimulation of certain groups of spinal nerves gives fairly constant reflexes, there are seemingly certain paths which offer less resistance to afferent impulses coming from isolated areas of the body. Is this due to special anatomical connection or is it a result of habit? Anatomically all parts of the nervous system are more or less directly connected with each other by the great commissural systems, the commissural and association fibers of the brain, the fasciculus

longitudinalis medialis of the brain stem and the basis bundles of the cord together with the intimate connection of the individual cells of ganglia; nuclei of origin and termination of different nerves, via the Golgi type II cells makes almost any reflex possible and by assuming that each synapse offers a certain resistance, the more constant reflexes may be explained upon the basis of a more direct anatomical connection or these involuntary reflexes may be the result of habit (just as many of our so-called voluntary reflexes are), the tendency of the organism being to adapt those things which are necessary and ignore in part those that are not of value. Pigeons, with all six ampullæ of semicircular canals destroyed, make eventually an excellent recovery, the very marked degree of which seems to be due to the fact that the bird learns to use his other sensory (reflex, afferent) data in co-ordinating his muscles. The responses which accomplish the most have been encouraged and those that were useless or detrimental have been inhibited; in this way a "habit" reflex path is opened up which collects and uses the energy of certain afferent paths (impulses) giving a definite response as long as nothing interferes with the integrity of the arc, but if the efferent neurone is completely or partially blocked or the strength or number the incoming impulses be sufficiently increased[1] they will seemingly flood this "habit path" and be spent in other parts of the nervous system. Schaffer[2] found on stimulation of the pinna or fore limb after hemisection of the cord in the dorsal region, that the movements of the hind limb which previous to the hemisection is less elicitable contralaterally than homonymously become easier contralaterally. In man both pupils dilate from exposure to light or other stimulation of one optic nerve or retina, from painful stimulation of the skin, the muscular exertion or dyspnea, while in some, tickling of the palms of the hands or soles of the feet causes an oscillation or dilation. Stimulation of naked sensory nerves in animals has the same effect.[3]

1 Dr. E. Rosencrantz. Howell's Text Book of Physiology, 3rd edition, p. 96—7.
2 Schafer text book of physiology, Vol. II, page 840.
3 Stewart text book of Physiology, Page 796—7.

Irritation to the mucous membrane of the nose causes a reflex dilation or contraction of the bronchus[4] and if continued a forced expiration constituting a sneeze. External heat, muscular exercise, dyspnea or strong emotions cause a reflex secretion of sweat.[5]

The stimulation of sensory nerves in general calls forth a variety of effects the more constant being an inhibition of pancreatic secretion[6] a secretion or inhibition of saliva, vasomotor changes, a constriction generally being the more prominent, but this is soon followed by a dilation (or fatigue.) Mechanical stimulation of the muscles of the rabbit invariably causes a slight fall in arterial pressure whereas mechanical stimulation of the skin causes a rise.[7]

The heart beat is generally increased by a mild stimulation and inhibited by a painful one.[8] Stimulation of the cardiac branches of the vagus have excited under certain circumstances not only their well known effect on blood pressure and rhythm of cardiac beat but a general reflex affecting the skeletal musculature. Faradisation of the central end of an intercostal nerve is far less efficient as regards blood pressure than excitation of the parent trunk including the visceral (sympathetic) afferent fibers.[9]

The smell of food,[10] carbon dioxide, methane or hydrogen sulphid,[11] accelerate peristalsis while CO^2 or stimulation of the central end of a sensory nerve will inhibit[12]. Dyspnoea may have either effect. Psychic changes have been the subject of much speculation, they may cause a perversion of any or several of the body functions. Osteopathically a cause (reflex)has been found for several of these so-called psychic effects.

Experimental lesions (mid and lower dorsal) in dogs produces glycosuria[13] while abnormal spinal movements produce cardiovascular change.[14]

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4 Stewart text book of Physiology, Page 209.
5 Howell text book of Physiology, 3rd edition, page 831.
6 Stewart text book of Physiology, page 334.
7 Schaffer text book of Physiology, Vol II, page 827.
8 Howell text book of Physiology, 3rd edition, page 566—574.
9 Bradford Journal of Physiology, Cambridge & London, 1897, Vol. X.
11 Howell, Page 704, 3rd edition.
12 Schafer, Page 324 and 335.
13 See Series No. 4. 14 See Series No. 2.

Methods: Dogs and pups were used for these experiments, ether was administered by means of a tracheal cannula. The anesthetic was kept "heavy" and constant. The animals were slightly atropinized to allay the effects of long stimulation of the heart. The abdomen opened and filled with warm normal salt solution. The sciatic nerve exposed, ligated, sectioned, and stimulated (control) to get their normal effects then the splanchnic nerve or nerves or their viscero-motor portions were sectioned, the sciatic again stimulated, the stimulus used being a strong or medium strength induced current applied for thirty seconds to three minutes. Exposure and cold were avoided and all operations were controlled by post mortem examinations.

Results: In a few cases stimulation of the sciatic with the splanchnics intact, either failed to stop or initiated a peristalsis, in these cases distinct bony lesions were noted in the dorsal region of the spine. Some dogs having lesions in the area did not react thus but gave the normal inhibition. After section of one splanchnic in dogs that reacted normally[15], the results were variable, in most cases a feeble peristalsis of the stomach would start at varying intervals to be lost before reaching the pylorus, in others a distinct peristalsis would be started which continued for a short time after removal of the stimulus. In normal dogs with both splanchnics cut, stimulation of a sensory (sciatic or cord of brachial) nerve caused peristalsis in the stomach (reflex over the vagus) which was generally continued on to the duodenum. Stimulation of the intact vagus with a weak induction current for 30 to 60 seconds decreased the latency period[16] and increased the strength of the peristalitic movement reflexly excited which previously was impossible to elicit or had been very weak. The latency period, character and duration after removal of the stimulus showed great individual variation. I observed in three cases with the splanchnics intact what I took to be a reverse peristalsis. The contractions were vigorous, beginning at the pylorus and progressing rapidly to the cardia, they were preceded by a wave of dilation and accompanied by a

15 An inhibition of peristalsis from stimulation of splanchnic nerve.
16 A relaxation (inhibition) preceding the contraction.

rigid contraction of the abdominal muscles. In one case with the splanchnics cut in the thorax I was unable to get a reflex peristalsis.

The following have been selected as typical experiments:

Experiment No. 28: Animal, medium sized dog.

9.43	Tracheal cannula inserted.
9.55	Right sciatic ligated and sectioned .
9.57	Left sciatic ligated and sectioned.
10.00	Abdomen opened.
10.20	Uterus removed containing pups.
10.27	1-200 gr. of atropin injected into the spleen.
10.36	Right sciatic stimulated. Stomach relaxed.
10.37	Stimulus removed .
10.48	Viscero-inhibitor portion of right splanchnic sectioned.
10.55	Left splanchnic sectioned.
10.56	Stimulation of central end of sciatic.
11.00	Stimulus removed, no peristalsis.
11.03	Stimulation of vagus.
11.03¾	Peristalsis started.
11.05½	Stimulus removed.
11.06¼	Stimulation of sciatic.
11.08½	Stimulus removed, peristalsis inhibited but not stopped.
11.11	Examination showed only part of right splanchnic cut, remaining portion sectioned.
11.14	Stimulation of sciatic.
11.14½	Peristalsis started.
11.15	Stimulus removed.
11.26	Peristalsis not stopped but weak, stimulation of sciatic, increased strength of contraction.
11.27	Stimulus removed.
11.29	Peristalsis stopped.
11.30	Stimulation of sciatic started, vigorous peristalsis.
11.31	Stimulus removed, contractions rapidly weakened and stopped at 11.34.
11.37	Animal killed. Post mortem, both splanchnics were found to be completely sectioned.

Experiment No. 20. Animal, large dog. Series No. 5, April 22, 1911.

Operation: Ether by means of tracheal cannula, both sciatics exposed and sectioned. Abdomen opened and filled with warm normal NaCl solution. 1-100 grain of atropin injected into spleen.

8.52 Stimulation of sciatic. No effect.
8.54 Stimulus removed.
9.00 Right splanchnic sectioned.
9.40 Left splanchnic sectioned.
9.44 Left sciatic stimulated.
9.48 Stimulus removed, no peristalsis.
9.50 Stimulation of right sciatic.
9.51½ Weak peristalsis.
9.52 Stimulus removed.
10.08 Stimulation of right sciatic.
10.08½ Peristalsis started.
10.09 Stimulus removed.

In this Series 29 animals in all were used and operations done as outlined above.

CONCLUSIONS:

(I.) Stimulation of the central end of a spinal or cranial sensory nerve equals in effect stimulation of the peripheral end of some sympathetic nerve or nerves.

(II.) The visceral (sympathetic sensory) afferent fibres appear to be particularly efficient for vasomotor reflexes.

(III.) There are special (habit) reactions for the stimulation of some afferent nerves but this specificity may be changed to a general reaction by anything that will decrease or interrupt the irritability or conductivity of the efferent element.

(IV.) Internal environment may open up other so-called specific reflex paths.

(V.) Anything which increases the irritability and conductivity of the efferent element increases its reflex response, this increase may be both qualitative and quantitative.

(VI.) Normally the general reflexes have a tendency to bring about passive (inhibitory) reactions.

(VII.) Other conditions being equal there is a tendency for homonymously related segments to respond.

VACCINIA AND VACCINATION

Series No. 6.

Bacteriological Research. [1]

J. Deason and W. R. Archer

Methods and Technique Employed in the Isolation of Bacteria from Vaccine Virus.

Experimental work was begun on this subject the latter part of September, 1910, and is still in progress at this date (April 10, 1911). The details have been carried out by the aid of a corps of seven assistants, under personal supervision.

For the purpose of examination, vaccine virus from two prominent manufacturers has been used and secured from time to time as needed, through the local drug stores, so that it would be as nearly fresh as possible and well within the limit of efficiency. Vaccine virus put up in two forms, both of which were glycerinated, were used for the tests. One was put up in the capillary glass tubes sealed with wax. These were in the original sealed packages and were not opened until everything was in readiness for the inoculation in media and examination under the microscope. Two series of experiments have been carried out, the second being substantially the same as the first, for the purpose of verification of findings.

The apparatus used in the work was essentially the same as that in use in any modern bacteriological laboratory; exceptional care, however, was taken to avoid errors in technique and possible sources of contamination from air, dust and unsterile apparatus, etc.

The media used for the development of cultures was blood serum, plain agar and glucose agar. Fresh blood was procured from a local slaughter house, under as nearly sterile conditions as possible and prepared after Loeffler's

1 A general review of the literature statistics, etc., was published with the Experimental work in the March, April and May numbers of the Journal of Osteopathy, 1911.

method, after which it was sterilized for nine consecutive days, twenty to thirty minutes at 85 C. After allowing to cool to 38 C., the media was incubated the remainder of the twenty-four hours for the purpose of developing any latent spores. The plain and glucose agar media were treated in a like manner for the same period, excepting that it was sterilized at 120 C. After all media had thus been sterilized it was then kept at room temperature for eight or ten days to allow the development of any possible saprophytes which might have escaped the sterilizing process and which would not grow at the higher, or body temperature.

After this test, the media showed no signs of bacterial growth and was considered ready for inoculation. To facilitate the work of making the transfers fifty culture tubes containing about ten c. c. of normal salt solution were sterilized for one hour at 120°C. for four successive days.

After everything was prepared, the tables were washed with 1-1000 bichloride solution. Hands of writer and of two assistants were washed with soap and water, then in bichloride of mercury solution, and then in 60% alcohol. Sterile laboratory gowns were donned, after which all glassware and other utensils were brought from the autoclaves and put upon the prepared tables. The original packages of vaccines were opened and the receptacles first immersed in a bichloride of mercury solution and then washed in alcohol and allowed to dry.

Eight of the ten capillary tubes were then opened and contents dropped directly into as many culture tubes of the salt solution, two being kept for microscopic examination. The capsule form had to be transferred to the solution by means of the platinum loop. This inoculated salt solution was then transferred to the Petri plates by means of pipettes, a fresh pipette being used for each tube containing the salt solution.

Thirty plates of each brand of virus were inoculated, and as many plates were inoculated with the salt solution which were thus exposed to the same risk of outside contamination as those which were inoculated with the virus. These Petri plates all contained blood serum media. Fifty culture tubes of glucose agar were inoculated by the plati-

num loop from the capsule virus and then sealed with melted paraffin for the development of cultures under anaerobic conditions. A like number of control tubes on media were sealed in the same manner. All Petri plates and culture tubes, including the controls, were placed in an incubator and kept at approximately 37° C. On the second day, plates and tubes began to show signs of bacterial growth. About the fifth day an examination showed two Petri plates which had been inoculated with virus still sterile, the rest showing from three to twenty colonies. Of the control plates one out of thirty showed contamination in the development of one small and one prolific colony growth. Of the tubes inoculated under anaerobic conditions, 90% showed growths, while all control tubes remained sterile. The Petri culture plates displayed a much greater variety of organism than did the tubes. The colonies which showed different characteristics were transferred to slant agar and blood media after the cultural descriptions had been recorded.

On the tenth day large numbers of colonies had developed on the plates, ranging from twenty-five to over one hundred. One of the plates which was apparently sterile at five days, then showed five or six colonies. More transfers were made to new media. Morphological, staining and cultural characteristics were then studied with a view of eliminating duplications of the same organism . Each different organism was recorded under a designating character. A description of one brand of virus being numbered, the other lettered. In this way we were able to isolate about eleven different organisms from one kind of virus, and fifteen from the other. Not over four of these were common to both kinds of vaccines. The two colonies found in the control plates proved to be organisms commonly found in contaminations from dust or air, and were unlike any of those found in the vaccine plates and tubes.

Microscopic examination of the vaccine virus seemed to reveal a larger number of various kinds of micro-organisms than we were able to grow on culture. On the other hand, we grew organisms that we could not demonstrate in the original virus. This could easily occur, because of

the difficulty in identifying the different organisms merely by their staining and morphological characteristics.

The number of bacteria visible at one time in the field of the scope varied from 0 to 50 or more. Sometimes not more than two or three organisms could be found in a whole specimen, while another smear from the same capsule would show large numbers, which could hardly be attributed to the grouping of colonies in the lymph, as these clumps were invariably of mixed varieties.

After the complete isolation of the various organisms, three culture tubes, containing different kinds were given to each assistant for careful study of all characteristics, such as morphological, staining, cultural and pathogenic properties. We present herewith several cuts, showing a reproduction of various organisms from photographs.

Methods and Technique Employed in the Inoculation of Laboratory Animals.

The primary object of the experiments on vaccine virus was to determine the presence or absence of micro-organisms, and, if found to be present, to show by cultural methods whether or not life existed, and, if so, to further prove or disprove their pathogenicity. For this latter purpose, a series of inoculation experiments on animals has been carefully carried out. The animals used in this part of the work for experimental purposes were dogs, rabbits and guinea pigs.

Before entering upon the details of our methods of inoculation, it may be well to explain that the pathogenicity of an organism is decided, and proved by various modes depending upon the circumstances and the nature of the disease which the micro-organism is suspected of producing. A small mass of the organisms in pure culture may be introduced under the skin through a small incision and is known as the "pocket inoculation." The culture may be introduced subcutaneously in a liquid suspension by means of a hypodermic needle, forming a nidus in the superficial fasciæ; or, it may be transfused directly into the vascular or lymph circulation; or, again, into a mucous membrane, into glandular tissue; or, into the peritoneal cavity; or

perhaps, for still other purposes, into the meninges or spinal cord, the conjunctiva, or even the chambers of the eye, as well as other locations. For our purpose, we deemed it advisable to employ the subcutaneous plan for the reason that any pathogenic bacteria which may be present in vaccine virus, must reach their seat of damage from the point of vaccination in an epidermic situation, and is not by the means employed in vaccination, introduced into the various other locations mentioned above. It is also a well known fact that an organism introduced, e. g., into the peritoneal cavity, may produce violent symptoms from septicaemia, where as, the same organism introduced subcutaneously may not cause any disturbance whatever. Therefore, to take advantage of this fact would hardly be fair to the object or our investigation. Infection by a pathogenic organism at the point of vaccination, or any other abrasion of the skin, may operate in several different ways; the infection may be carried by the blood stream to the body viscera; it may extend by way of the lymph channels involving the glands; or, it may produce phagedenic ulceration of the original lesion. Again, the organism may proliferate at the point of infection without marked local disturbance, yet the toxins produced by such organism may be deadly in effect by acting directly on the nervous system, as is the case of infection by tetanus bacilli.

The various animals used in our laboratory experiments were kept in separate cages from three to six weeks before being used either as controls, or for inoculation, and fed upon a specific diet to see that they remained in perfect health under such circumstances before they were deemed fit for experimental use.

Attendants in charge of the feeding and care of these animals had no immediate knowledge of the work carried on in the laboratory, or any particular information as to which animals were or were not inoculated. When an animal was removed to the laboratory for inoculation, the operation was recorded by the number of its cage, it being the duty of a special attendant to thoroughly clean and disinfect the cage before such animal was returned. Sanitary conditions of the cages were maintained at all times.

The laboratory method of inoculation in these animals by the various organisms isolated from vaccine virus was substantially as follows: Each animal on being brought into the laboratory, was prepared by having a spot about one and a half inches in diameter cleanly shaven, usually the abdomen just posterior to the umbilicus, but a few were inoculated on the inferior maxillary near the angle over the parotid gland. The place was then thoroughly cleansed, first with soap, water and brush, then with 60% ethyl alcohol, which was allowed to remain from one to two minutes and then rinsed off with sterile water, it being impossible of course, to render the skin perfectly sterile. The animal thus prepared for inoculation, the procedure and operation was carried out in the following manner: A liquid suspension was made of one of the organisms which had been isolated from the virus, and which had been grown on fresh media for 24 hours. In some cases, a physiological saline solution was used, while in others, peptone broth was utilized. In both methods of inoculation, the mode of making the suspension was the same. About ten c. c. of either of these fluids which had been previously sterilized, was transferred to the culture tube by means of a pipette and which was then gently shaken in order to dislodge and mix the organism in the liquid. This suspension was allowed to remain in the incubator about two hours at a temperature of 37° C., and it was then transferred to a small sterile beaker, warmed to about the same temperature and immediately used. The operation of inoculating was performed by means of the hypodermic syringe having a metal barrel of one c. c. capacity, and which was thoroughly sterilized by boiling. The needle of the hypodermic was inserted under the skin by a quick thrust and the suspension of the organism was deposited subcutaneously in the superficial fascia. The wound made by the needle was then sealed with collodion to prevent the possibility of accidental infection.

The quantities of the suspension used, differed with different animals, and also depended upon whether it was the first, second or third inoculation by the same organism. For the primary inoculation in a small dog, about two c. c. of the suspension was injected; for a large dog from two

to three c. c. were used; in a rabbit, from one to two c. c. and in guinea pigs, usually one c. c. In case the animal showed pathological symptoms or was killed by the effects, and the organism recovered and grown on artificial media, the quantity for the next inoculation was materially lessened. After inoculation the animal was returned to the individual cage in which it had been previously kept and continued under identical care as formerly, a daily record being kept of its condition of weight, appetite, behavior and pathological symptoms. To avoid the possibility of error as to the effects of these inoculations, we have kept animals for controls which were not inoculated and which were cared for in an identical manner as were the experimental animals. At the present time not one of these control animals had died, while of those that were inoculated, thirty-three have succumbed to pathological lesions unmistakably produced by the organisms with which they were inoculated. Deaths occurred in three dogs, three rabbits and twenty-seven guinea pigs.

The proof of the pathogenicity of an organism is to be able to recover from a pathological lesion the same kind of organism with which the animal was inoculated, to grow it on artificial media, and again recover it in pure culture. (After the method of Koch.) It is usually an easy matter to determine whether an animal died from an accidental infection which rarely occurs, or from the organism with which the animal was originally inoculated.

Upon the death of an animal, a post mortem examination was immediately made. The lesion at the site of inoculation was carefully examined, and a large number of stains made of pus or serous fluid found, as well as transfers to culture media. The body was then laid open from the upper thorax to the pelvis, and the heart, lungs, stomach, liver, pancreas, spleen, kidneys, intestines and other viscera were carefully examined and stains made of the various fluids and secretions. The findings varied greatly as to the action of the different inoculations, as well as the time required to produce death. In some, the organism was found to have permeated the remotest parts of the body, while others remained more localized. Many animals

showed constitutional symptoms; others a bad local condition—that is to say, an ulceration or necrosis of tissue and sloughing out; yet death did not occur. (See cut No. 21.) The death of the animal is not an essential factor in the proof of pathogenicity but denotes merely a higher degree of virulence. Again, it must not be concluded from these experiments that all germs which are pathogenic to laboratory animals, are pathogenic to man; yet there is a probability of their being so. What may prove pathogenic to one kind of animal might not be to another.

Morphological, Cultural, Staining and Pathogenic Characteristics of Bacteria Isolated From Vaccine Virus.

No. 1. Morphology.—Baccillus, .7x3 to 5 microns. Cell grouping, from media, usually in singles from lesion as diplo or chain. No spores. Not pleomorphic or involute. Non-motile.

Cultural Characteristics:

1. Blood serum: vigorous, dry, opaque, spreading growth, whitish in color. Liquified media in six days.
2. Slant agar: growth similar to blood serum, except no liquifaction occurred.
3. Dextrose: spreading prolific growth with gas production.
4. Litmus milk: acid reaction, coagulative and proteolytic.
5. Potato: vigorous spreading, grayish-white growth.

Relation to Oxygen: aerobic and facultative anaerobic.

Staining: by all aniline dyes and Gram positive.

Pathogenicity: pathogenic to dog, and mortal to rabbit and guinea pig.

No. 2. Morphology—Bacillus, 1.5x3 to 6 microns. Cell grouping, singles, sporulative on potato media; non-motile; no capsule.

Cultural:

1. Blood serum: vigorous gray growth, better at 25° C. than body temperature; no liquifaction.
2. Slant agar: similar to growth on blood.
3. Dextrose: no gas production, but good growth.
4. Litmus milk: acid reaction, non-coagulative.

5. Potato: vigorous growth with spore formation.

Relation to oxygen: aerobic and facultative anaerobic.

Staining: by all aniline dyes and is Gram positive.

Pathogenicity: mortal to guinea pig; not inoculated in rabbit.

No. 3. Morphology.—Bacillus, 1x3 to 10 microns; cell grouping, single; no spores; no capsule and non-motile. Cultural:

1. Blood serum: rather scant, elevated grayish growth with no liquifaction, showing tendency to cause blood to dry out.
2. Slant agar: thin translucent film-like growth in 24 hours. Showed slow but continuous growth for two weeks.
3. Dextrose: slight surface growth; no gas formation.
4. Litmus milk: strongly acid in reaction after 24 hours; slightly coagulative, but not proteolytic.
5. Potato: thin spreading growth, film-like in formation.

Staining: stains readily with all common dyes, but is Gram negative.

Pathogenicity: killed guinea pig in 19 days by first inoculation, the organism being recovered from abscess at point of insertion, but not from body viscera. The second inoculation proved mortal in four days.

No. 4. Morphology.—Occurred in long thin filaments resembling actinomyces bovis. As the culture grows older these filaments become segmented and finally granular. Cultural:

1. Grew well on blood when first isolated from the virus, but after it had been transferred a few times, its growth was slow and scant, producing a tough membranous substance, dark in color. On plate cultures, it formed small round circumscribed, elevated colonies of hard consistency and dark in color.
2. Slant agar: growth spreading, scant, opaque, whitish in color and moist. Not so hard or elevated as on blood serum.
3. Dextrose: growth scant with slight gas production.
4. Litmus milk: slight growth, if any, with no apparent change or reaction on the milk.

5. Potato: growth limited.

Relation to oxygen: aerobic and facultative anaerobic.

Staining: all the common dyes and is Gram positive.

Pathogenicity: Of three guinea pigs inoculated with this organism, one died in twenty-one days and two recovered, each showing pathogenic symptoms.

No. 5. Morphology.—Large bacillus, 1.5x4 to 6 microns. Motility: flagella demonstrated.

1. Blood serum: vigorous, spreading, grayish white color, opaque, elevated, moist, and liquifaction of the media after three days.
2. Slant agar: growth similar to that on blood.
3. Dextrose: vigorous growth with gas formation.
4. Litmus milk: Acid reaction, coagulative and proteolytic.
5. Potato: rapid spreading, elevated and moist growth.

Relation to oxygen: aerobic and facultative anaerobic.

Staining: Stains with all aniline dyes; is acid fast and Gram positive.

Pathogenicity: This organism is extremely pathogenic to all laboratory animals. The first inocuation in guinea pig caused death in 36 hours. Showed great prostration and paralysis of legs within 12 hours. On post mortem examination, the organism was recovered from original lesion, and from body viscera and blood. The second animal, a six months old dog, was inoculated from a culture grown from the blood of the first animal using 1.5 c. c. of suspension, causing death in 10 hours. From this animal the same organism was again recovered, cultured and inoculated with five drops of the suspension. Briefly, the history if this animal showed much distress in 12 hours. In 48 hours the site of inoculation was badly swollen and dog was very stiff in hind legs. In 72 hours the inguinal glands were intensely enlarged and a bluish discoloration of the swelling on abdomen. The dog refusing food and water. Symptoms increased until the fourth day when the abscess which formed at the place of inoculation, ruptured, exuding a grayish-white pus. On the sixth day, the dog was all but dead, and was anesthetized

to put it out of distress. Post mortem examination revealed a pyogenic condition in all viscera.

No. 6. Morphology.—Coccus, .8 to 1 micron in diameter. Cell grouping from media, single, from lesion in clusters.

1. Blood serum: Vigorous, spreading, opaque, elevated and moist, whitish colored growth.
2. Slant agar: similar to growth on blood serum.
3. Dextrose: confined to needle track, with gas production.
4. Litmus milk: neutral reaction; no coagulation.
5. Potato: no visible growth.

Relation to oxygen: aerobic and facultative anaerobic.

Staining: all aniline dyes, Gram positive; not acid fast.

Pathogenicity: is highly pathogenic to all laboratory animals on which it was tested.

(It will be noticed that this organism in many respects bears a close resemblance to the staphylococci group.)

No. 7. —Morphology.—Bacillus, 1.5x5 to 10 microns. Cell grouping, single. Flagellated and motile.

Cultural:

1. Blood media: vigorous and pellicle on water of condensation.
2. Plain agar media: vigorous and rapid spreading growth.
3. Dextrose: surface growth only, with no gas formation.
4. Litmus milk: neutral reaction, not coagulative or proteolytic in action.
5. Potato: a prolific rapid growth, covering the entire surface.

Relation to oxygen: aerobic in nature.

Staining: stains with all common dyes, is Gram positive; slightly when first grown on media, but becomes decidedly positive when passed through animals.

Pathogenicity: produces a marked, spreading and penetrating ulcer, with much sloughing of tissues. The lesion remaining circumscribed in dogs and rabbits from which they recovered in about three weeks. More fatal to guinea pigs.

No. 8—Morphology.—Bacillus, 1x4 to 8 microns in size. Cell grouping, single, with tendency to form chains in lesion. No flagella or motility demonstrated. No spores and not pleomorphic.

Cultural:

1. Vigorous, spreading and elevated in folds; little or no moisture. Dark gray in color when grown on blood.
2. Plain agar: Growth very similar to that on blood.
3. Dextrose: spread from needle track, with vigorous growth on surface very much elevated. Gas production in depth of media.
4. Litmus milk: strongly acid in reaction, coagulative and proteolytic in action.

Relation to oxygen: grows well either with or without oxygen.

Staining: stains well with all common dyes; is Gram positive.

Pathogenicity: highly pathogenic to all laboratory animals. Two c. c. of suspension produced death of dog in ten days on first inoculation. Organisms recovered from this animal and cultured proved fatal to guinea pigs in 12 to 15 hours, in all cases the inoculation produced pyemia, which was diffused throughout the body, with all viscera badly congested. The first symptom to appear was paralysis or the loss of ability to use legs. The organisms were recovered from the body fluids.

No. 9. Morphology.—Bacillus, about .5 to .7x3 microns in size, which occurs in single arrangement either from media or when recovered from lesion. Is motile, although flagella were not demonstrated.

Cultural:

1. Blood serum: spreading, prolific growth, somewhat rugose, moist and of a yellowish color.
2. Plain agar: growth practically the same as on blood serum.
3. Dextrose: vigorous growth in media and on surface, with gas production.
4. Litmus milk: acid reaction, coagulative and proteolytic.
5. Potato: similar to that on agar and blood serum.

Relation to oxygen: aerobic and facultative anaerobic.

Staining: all aniline dyes and is Gram positive.

Pathogenicity: fatal to guinea pigs on first inoculation in about 48 hours. Pathogenic to dog but not mortal.

No. 10.—Morphology.—Bacillus, short rod, .7x2 microns. Cell grouping single. Involute, granular, no spores.

Cultural:

1. Blood serum; growth vigorous, elevated, moist, spreading, opaque, and grayish in color.
2. Plain agar: growth same as on blood serum.
3. Dextrose: spread from needle track and vigorous, but no gas production.
4. Litmus milk: acid reaction, coagulative and slightly proteolytic in action.
5. Potato: growth, but very scant.
6. Bouillon: growth prolific, with heavy rugose film on surface.

Relation to oxygen: aerobic and facultative anaerobic.

Staining: all aniline dyes; is Gram positive.

Pathogenicity: highly pathogenic to dogs, rabbits and guinea pigs.

No. 11.—Morphology.—Bacillus, about .5x1.5 to 3 microns in size. Cell grouping, single; some motility; not pleomorphic or involute.

Cultural:

1. Blood serum: vigorous, elevated, moist, spreading, and pearly gray in color.
2. Plain agar: same as on blood media, except less vigorous.
3. Dextrose: spread from needle track, with gas production.
4. Litmus milk: acid reaction, coagulative after 48 hours, with peptonization of curd.
5. Potato: scant yellowish growth after 48 hours.

Relation to oxygen: aerobic, or anaerobic.

Staining: all aniline dyes, and is Gram negative.

Pathogenicity: Pathogenic to dogs and fatal to guinea pigs.

No. 12.—Morphology.—Bacillus, .7 to 1x3 to 5 microns in size; forms long chains, and is pleomorphic and involute, with spores.

Cultural:

1. Blood serum: vigorous, brownish colored growth, opaque, rather hard consistency and somewhat elevated.
2. Plain agar: vigorous, spreading and elevated growth; more of a gray color than on blood serum.
3. Dextrose: surface growth, but none in depth of media. No gas production.
4. Litmus milk: No apparent changes in this medium.

5. Potato: a good growth and similar in nature to that on agar.

Stains: stains with all common dyes and is Gram positive.

Relation to oxygen, aerobic and facultative anaerobic.

Pathogenicity: all tests made were negative in results.

No. 13.—Morphology.—Coccus, .6 to .9 micron in diameter. Cell grouping, diplos and in clusters.

Cultural:

1. Blood serum: not vigorous in growth; small pearly-gray circumscribed colonies.
2. Plain agar: vigorous and elevated, whitish in color.
3. Dextrose: surface growth only. No gas production.
4. Litmus milk: acid in reaction; no coagulation or proteolytic action.
5. Potato: spreading, prolific growth.

Stains: all common dyes and is Gram positive.

Relation to oxygen: aerobic only.

Pathogenicity: Not shown to be pathogenic to laboratory animals.

No. 14.—Morphology.—Bacillus, .5 to .7x3 to 5 microns in size; occurs in singles, sporulative, not pleomorphic.

Cultural:

1. Blood serum: vigorous, grayish-white, elevated, moist, soft and spreading growth.
2. Plain agar: same characteristics as on blood.
3. Dextrose, not tested in this medium.
4. Litmus milk: strongly acid in reaction in 12 hours. Coagulative, and but slightly proteolytic in action.

Potato: not very vigorous, whitish, elevated, moist growth.

Relation to oxygen: aerobic and facultative anaerobic.

Staining: by all common dyes and is Gram positive.

Pathogenicity: mortal to guinea pigs.

No. 15.—Morphology.—Bacillus, .7x3 to 5 microns in size. Cell grouping is single; not pleomorphic or involute and has no spores.

Cultural:

1. Blood serum: whitish film-like growth with rugose elevations, soft, spreading, vigorous and moist.

2. Plain agar: luxuriant growth similar to that on blood serum.
3. Dextrose: grows well in this medium, without gas production.
4. Litmus milk: acid reaction, no coagulation of proteolysis.
5. Potato: yellowish spreading corrugated colony.
6. Bouillon: thick grayish film on surface.

Relation to oxygen: aerobic and facultative anaerobic.

Staining: all aniline dyes and is Gram positive.

Pathogenicity: This organism is pathogenic and highly pyogenic. The germs being recovered in the various body viscera with much pus formation. Guinea pigs die in from three to five days.

No. 16.—(See cut.)—Morphology.—Bacillus, .7x5 microns in size; occurring as rods and clubs, arranged as singles; no motility demonstrated.

Cultural:

1. Blood serum: scant, elevated and irregular colonies.
2. Plain agar: scant, grayish white nodular growth, firm and dry.
3. Dextrose: not grown in this medium.
4. Litmus milk: acid in 12 hours; coagulative and proteolytic after 48 hours.
5. Potato, slow at first, but vigorous after 48 hours; elevated, irregular friable colonies.
6. Bouillon: not prolific in this medium.

Relation to oxygen: aerobic and facultative anaerobic.

Staining: all aniline dyes, and Gram negative.

Pathogenicity: fatal to guinea pig in 20 days on first inoculation; much quicker after first transmission. Organism recovered from tissues near point of inoculation and from blood of animal.

No. 17.—Morphology.—Bacillus 1x6 microns in size; occurring in chain formation; spores.

Cultural:

1. Blood serum: vigorous, spreading dry growth, grayish in color and irregularly elevated.
2. Plain agar: same as on blood, except more moist.

Litmus milk: very acid in reaction, but caused no coagulation or proteolysis.

4. Dextrous: vigorous on surface, but limited in depths of medium. No gas production.

5. Potato: vigorous spreading, elevated, somewhat nodular; tendency to be more dry and friable.
6. Bouillon: does not grow well in this medium.

Relation to oxygen: aerobic, with scant growth as an aerobe.

Staining: all the common dyes, and is Gram positive.

Pathogenicity: produced bad ulcerating lesion at point of inoculation, from which the organism was recovered. Death did not ensue.

No. 18.—(See cut.)—Morphology.—Bacillus, .7x2 to 5 microns in size. Cell grouping occurs only as singles; no spores and not pleomorphic or involute; motility not tested.

Cultural:

1. Blood serum: vigorous, irregular elevated dry growth.
2. Plain agar: growth similar to that on blood, except more moist and not so friable.
3. Dextrose: not grown on this medium.
4. Litmus milk: acid in reaction after 24 hours. Coagulation after 48 hours. No proteolytic action.
5. Potato: vigorous, spreading moist growth, grayish white color.
6. Bouillon: prolific film-like growth with rugose elevations.

Relation to oxygen: aerobic only.

Staining: all aniline dyes and is Gram negative.

Pathogenicity: fatal to guinea pig; pathogenic to rabbit, but not tested on dog.

No. 19.—(See cut.)—Morphology.—Bacillus, .7 to 1x4 to 6 microns in size; occurs in single arrangement. Not pleomorphic or involute. No spores.

Cultural:

1. Blood serum: irregular spreading growth.
2. Plain agar: growth similar to that on blood, but not so vigorous.
3. Dextrose: surface growth, with no gas production.
4. Litmus milk: acid reaction; coagulation and proteolysis.
5. Potato: produces a vigorous spreading growth.
6. Bouillon: does not grow well on this medium.

Relation to oxygen: aerobic only.

Staining: All aniline dyes and is Gram negative.

Pathogenicity: is pyogenic, but not fatal to laboratory animals. Organisms recovered in pure culture from ulcerated lesion.

No. 20.—(See cut.)—Morphology.—Bacillus, .8x5 microns in size. Cell grouping, short chains and single. Not pleomorphic or involute. Motility not demonstrated. No spores.

Cultural:

1. Blood serum: vigorous, spreading irregular whitish growth. Liquifies this medium after some days.
2. Plain agar: a whitish brittle, dry, irregular growth.
3. Dextrose: good growth in depth of media, with elevated colonies on surface. Produces much gas.
4. Litmus milk: slightly acid reaction; coagulative and proteolytic in action.
5. Potato: a prolific, irregular grayish white growth.

Relation to oxygen: both aerobic and anaerobic in nature.

Staining: by all aniline dyes and is Gram positive.

Pathogenicity: Produces effects very similar to organism No. 1. which it resembles very closely in all respects, and may be the same germ and common to both kinds of vaccines.

No. 21.—Morphology.—Bacillus, .8 to 1x4 to 8 microns in size. Cells arranged in singles. No spores. Pleomorphic, involute. Motile characteristics not studied.

Cultural:

1. Blood serum: a vigorous spreading growth of a brownish color.
2. Plain agar: spreading, elevated, moist growth.
3. Dextrose: does not produce gas.
4. Litmus milk: acid reaction and coagulative, but not proteolytic.
5. Potato: rapid luxuriant growth.

Relation to oxygen: aerobic and facultative anaerobic.

Staining: stains readily with all simple dyes and is Gram negative.

Pathogenicity: This organism is purely a saprophyte and is not pathogenic.

No. 22.—This organism was clearly a staphylococcus pyogenes albus, the pathogenicity and general characteristics of which may be found in any text on bacteriology, therefore description is not essential here. Staphylococcus pyogenes aureus and streptococcus pyogenes were also found.

We have isolated seven or eight other micro-organisms which did not prove to be pathogenic and are of no particular consequence. Space forbids a detailed description here. The fact that we have grown a larger number of pathogenic than saprophytic organisms is probably due to the fact that our cultural conditions have been favorable to the growth of the former and unfavorable to the latter. The incubators being kept constantly at or very near 37.5°C. temperature, which is as a rule inhibitory to saprophytes.

We have endeavored in the foregoing to give our technique briefly, but sufficiently complete that any one may verify the findings by conducting similar experiments.

The organisms which we have isolated are now being tested as to their resistance to chemical germicides, but which for obvious reasons cannot be given at this time.

Due credit is hereby acknowledged for the valued and efficient assistance rendered in these experiments by S. V. Robuck, H. S. Whitiker, E. G. Story, Fannie G. Stoner, and Laura O. Jackson, student assistants in the American School of Osteopathy.

OSTEOPATHIC STIMULATION AND INHIBITION[1]

Series No. 7.

H. L. Collins and Charles R. Eitel.[2]

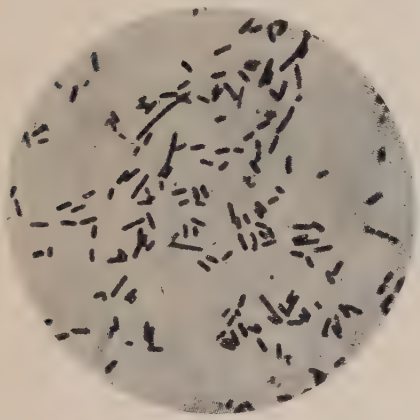
It has been claimed by members of the profession that osteopathic manipulation, such as vigorous movements of one or more of the spinal segments either alone or with deep manipulation of muscles are stimulatory in nature, meaning that such changes as increase in heart beat, both rate and amplitude, increase in blood pressure, increase in body temperature, and, in fact, an increase in many or possibly all functional activities controlled by nerves from these segments, may be effected, and that its effects be directed to certain body organs. The theory claims also that by deep and well regulated pressure applied to the spine a diametrically opposite effect, or inhibition of the functions of those structures supplied by nerves from the segments pressed upon may be produced.

On the other hand, there are those physicians who claim that neither stimulation nor inhibition results from osteopathic treatment but that it is only a normalization. That is, if an osteopathic lesion of any type, bony or otherwise, exists which is responsible for perversion of function, the correction of this lesion will result in a normalization of the function. Thus, if the lesion has caused a decreased functional activity of a certain organ, this functional activity will be raised to or toward the normal after the lesion is adjusted; and if the functional activity is increased, by reason of the lesion, it will be reduced to normal upon readjustment of the structural condition.

1 This was published first in the Journal of the A. O. A., July, 1912.

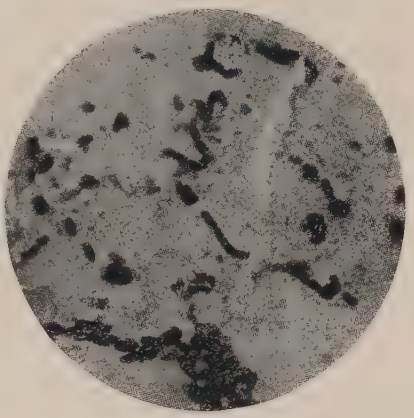
2 This work was suggested by Dr. Deason for the purpose of determining whether the so-called osteopathic stimulation and inhibition effects, as claimed by some physicians, could be demonstrated upon animals and also for the purpose of doing some control work on mammalian Series No. 2 done last year by Drs. Deason and Robb.

Photomicrographs of Bacteria Isolated from Vaccine Virus



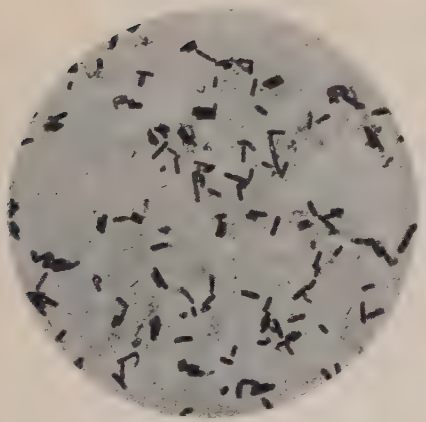
No. 1 X-1000 Gentian Violet Stain

This organism is pathogenic.



No. 2 X-1200 Gentain Violet Stain

This stain was made from a culture grown on potato media. This organism shows spores.



No. 3 X-1000 Gentian Violet Stain

This organism has not as yet been shown to be pathogenic.

No. 4 X-1000 Gram Stain

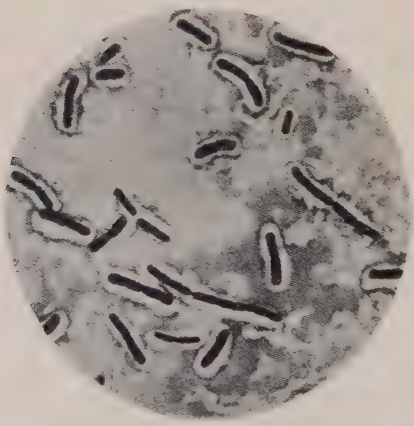
This organism has not yet been shown to be pathogenic.

No. 5 X-1000 Gram Stain

The organism occasionally shows spores, a few may be seen in the stain. This germ is very pathogenic to rabbits, guinea pigs and dogs.

No. 6 X-1000 Gentian Violet Stain

Pathogenicity of this germ has not been determined.



No. 7 X-1000

Gram Stain made from a lesion of an inoculated animal. This organism is very pathogenic.

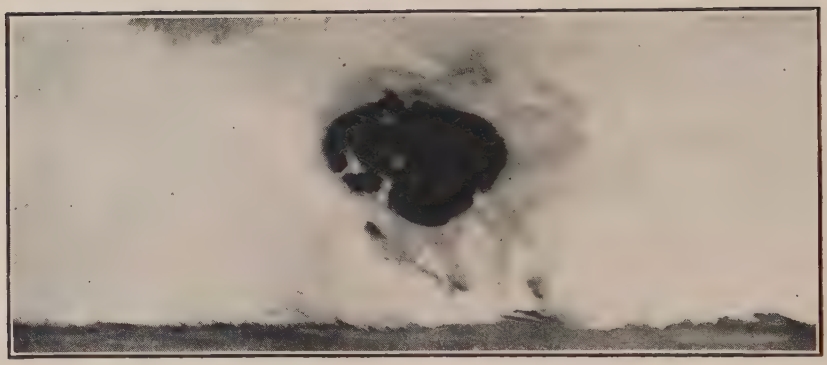
No. 8 Gentain X-1000 Violet Stain

This organism is pathogenic. A more complete discussion of these organisms will be presented with the next article.

Series 6.

No. 22—An ulcer developed on the abdomen at the point of inoculation and spread to the inguinal glands. The infection resulted in paralysis of the hind limbs after 12 hours and the dog could not stand. The organism used for inoculation was No. 5, a cut of which was shown last month.

No. 23—Two large ulcers two inches in depth formed after three days at the point of inoculation. This photograph was made on the sixth day after inoculation. The organism used was No. 5, shown in the Journal of last month. See description under organism No. 5.



No. 21—This cut was made from a photograph of an ulcer on the abdomen of a large white rabbit. The ulcer formed at the point of inoculation two weeks after the animal was inoculated.

Cut No. 7 shows a stain of the organism made from this ulcer.

By the above definition we do not refer to the question of osteopathic inhibition (pressure) applied over areas of the body other than spinal regions. That pressure applied over certain nerve trunks and visceral structures will result in the reduction of pain and other functional disturbances had been demonstrated by clinical experiences of many osteopathic practitioners. Tasker, in his 1903 edition of "Principles," defines inhibition as follows:

"By the term inhibition, we do not attempt to convey any other meaning than that of pressure applied at some particular point on the surface of the body for the purpose of lessening the hyperactivity or hyperaesthesia of the immediate or some distant part of the body."

"The inhibition itself does, in some cases, remove what we choose to call a lesion, in other cases it may make the removal of a lesion possible, but in the majority of cases its effect is purely on the nerves, thereby acting on both the sensory and motor portion of the reflex arc, lessening muscular contraction and pain."

Concerning this definition, it has been found experimentally upon monkeys by Dr. Deason, the results of which are published in this bulletin, that pressure when effective in the reduction of lesions tends to normalize or reduce functional disturbances. Aside from this, pressure and manipulation in the spinal region give the same result.

It seems that no great amount of research work has been done along this line. There was published in the August number of the Journal of the American Osteopathic Association, 1907, a series of experiments by Pearl A. Bliss, D. O., which we mention here. The results of this series (experiments one to seven inclusive) seem to show a marked decrease in blood pressure from inhibition in the splanchnic region (we presume the mid or lower thoracic region is meant by the term "splanchnic region"). This we have found to be true, but we find further that any manipulation of this area whether of the so-called inhibitory or stimulatory type produces a similar effect. The results of this series seem to show further that the so-called osteopathic stimulatory manipulation applied to the upper thoracic region is followed by vaso constriction and, therefore, an increase in blood pressure; the effects on amplitude or

rate of heart beat are not stated nor can we determine this from the cuts given.

Our results confirm these experiments only in part: viz., that any kind of manipulation whether of the so-called stimulatory or inhibitory type, when applied to the lower dorsal produces a decrease in systemic blood pressure, and either manipulation or pressure applied to the upper thoracic region gives an increase in blood pressure. The effects on heart beat will be found below.

Doubtless every osteopathic physician from his own clinical experience has arrived at some conclusion concerning this question, and so we shall have nothing to say relative to the clinical side, but shall state the results of our findings from animal experimentation.

Methods and Technique.—Considerable care was used in the selection of the animals for these experiments; dogs were used, because blood pressure and pulse tracings can be more readily determined, and the results from manipulation and pressure are more satisfactory on dogs than from smaller animals. No animal was used which was not in a healthy condition and normal. The reason for the above precautions will be better understood when the reader is reminded of the fact that the average dog is frequently found suffering from some disease which may be traced to a spinal lesion (Series 1, 2 and 3). This fact has been many times corroborated by experimental work in the A. S. O. during the past year. It is a well-known fact that all animals do not exhibit the same normal functions when operated upon under anaesthesia. It is necessary, therefore, to experiment on several animals, and take the average results of those which seem to display the most normal reactions under anaesthesia. The following results have been taken from an average of fifteen animals operated.

The animals were kept under complete and uniform ether anaesthesia during the operation. When working on the lower dorsal and lumbar, tracheal cannula was used and the blood pressure and pulse tracings were taken from the carotid artery by the use of a carotid cannula, mercury manometer, and revolving kymograph. In some instances respiration was recorded, taken from the side arm of the

T tube, connected on the one hand to the tracheal cannula and on the other to a diaphragm tambour, and the tracing No. 4 which was recorded simultaneously with taking the blood pressure. When work on the lower cervical and upper dorsal was done, the anesthetic was given by an ether cone and the blood pressure was taken from the femoral artery instead of the carotid; the reason for this change being to place the apparatus so that it would be least interfered with.

A number of tracings was taken from each animal before the tests were applied to determine whether or not the animal was showing normal functional activities. Several minutes were allowed before and after each test for normalization. All results from animals whose tracings failed to show normal activities before any tests were applied were discarded. Great precaution was taken in these experiments, to disturb the animal as little as possible. For example, when flexion of the spine was produced in the upper dorsal the animal was placed on its side and with a fixed point in the upper dorsal as a fulcrum, the upper part of the spine was flexed backwards. In this way there would be no gravity effects to consider and the variation must therefore be produced by nerve stimulation alone. A few experiments were tried to determine the effect of gravity on blood pressure, for instance, a carotid cannula was used for blood pressure and the caudal end of the animal was raised until the animal was in a vertical position. There was a slight increase in blood pressure rarely exceeding 2 m. m. of mercury and this was transient, the blood pressure dropping immediately to normal when the caudal end of the animal was returned to the table.

It has been sufficiently demonstrated (Series 1 and 2) that the pressure results were not due to massage but to pressure stimulation alone, for although in cutaneous and deep muscular pressure stimulation, slight variations in blood pressure, heart rate and respiration were usually, though not always, produced, they returned to normal as soon as the stimulation was discontinued; while when in direct pressure stimulation of the spine the blood pressure remained increased for several minutes after the stimulation was removed.

Results.

Of the fifteen dogs used in these experiments, detailed reports will be given of seven. The results obtained from the other eight were similar to these.

Dog No. 1. Manipulation of the lower cervical region, caused an extreme variation in blood pressure, which possibly could have been due to some abnormal position or movement of the animal; since it was almost impossible to manipulate, and at the same time hold the rest of its body perfectly still. The results obtained on this animal were directly opposite to those obtained from all the others; this may be accounted for by assuming that it was abnormal in some way, since the results from all the others were so uniform. Seven tracings were taken; five, when pressure was applied, two when manipulation was used.

With Pressure: Tracing No. 1. A decrease in both rate and amplitude of heart beat, also a decrease in blood pressure, was obtained; Tracing No. 2, 3, 4, 5. A decrease in blood pressure resulted, while rate and amplitude of heart beat were not affected.

Fig. 1.—

With Manipulation: Tracing No. 1. There was quite a variation in blood pressure, but while it varied, it also fell perceptibly. Rate and amplitude of heart beat were not affected; Tracing No. 2. Here there was a decrease in both blood pressure and amplitude of heart beat, the rate remaining the same.

Dog No. 2. In this animal the effects of manipulation, flexion and pressure in the lower cervical and upper dorsal regions were demonstrated. The effects on blood pressure principally were noted.

By Manipulation: Tracing No. 1. Showed an increase of 9 m. m. of mercury in blood pressure; rate and amplitude of heart beat being unaffected; Tracing No. 2 gave an increase of 5 m. m. of mercury in blood pressure; rate and amplitude of heart beat being unaffected. In this case, however, the blood pressure returned almost at once to normal.

By Flexion: Tracing No. 1. Blood pressure was increased 12 m. m., rate and amplitude of heart beat were not affected. (Fig. No. 3.) The extreme variation in blood pressure, when flexion was first applied, (Fig. No. 1), was probably due to some defect in the arrangement of the apparatus, or to some movement of the animal, but when flexion was fully established the animal was held perfectly still, and the blood pressure remained increased as may be seen in the tracing. Tracing No. 2. In this case an increase of 4 m. m. in blood pressure resulted. Rate and amplitude of heart beat being unaffected.

By pressure: In this instance an increase of 3 m. m. in blood pressure resulted. (Fig. No. 2.) Also 0.5 m. m. increase in amplitude of heart beat, rate remaining the same.

Fig. 2.—

Dog No. 3. Three records were made from this animal, the object being principally to demonstrate the results of osteopathic manipulation in the lower cervical and upper dorsal regions. Tracing No. 1. In this case the blood pressure was increased 3 to 5 m. m.; rate and amplitude of heart beat remaining constant. The blood pressure remained up some time after stimulation was removed; Tracing No. 2. Here the blood pressure was raised 3 m. m., and remained so; rate and amplitude of heart beat remaining constant; Tracing No. 3. Here the blood pressure raised 2 to 4 m. m. and remained up; rate and amplitude of heart beat was unchanged.

Dog No. 4. Two tracings taken from this animal were kept for reference. Tracing No. 1. (Fig. No. 3.) The following results were obtained: By pressure in the upper dorsal, produced by means of a block placed under that region, the blood pressure was first decreased for a few seconds and then increased 13 m. m., remaining thus for 2.5 minutes . It remained 5 m. m. above normal for 3 minutes, when the tracing was removed. Tracing No. 2. A decrease in blood pressure of 5 m. m. resulted, also an extreme variation in both rate and amplitude of heart beat. Stimulation was applied in the same manner as in No. 1. Tracing No. 3. By applying heavy pressure to the upper

dorsal region, an increase of 10 m. m. in blood pressure resulted, remaining at this point for 3 minutes.

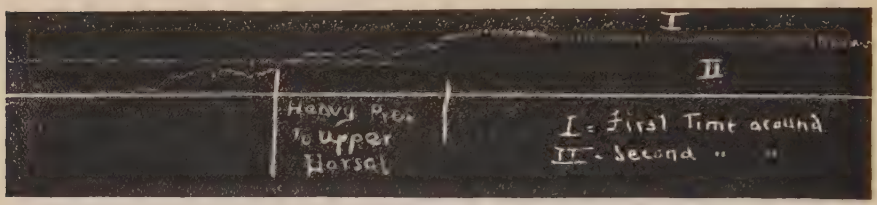


Fig. 3.—

Dog No. 5. Two methods were used on this animal, viz., osteopathic manipulation and the so-called osteopathic inhibition: Tracing No. 1. When osteopathic manipulation was applied to the lower cervical region, there resulted first a slight decrease and then an increase of 3 m. m. in blood pressure.

The rate and amplitude of heart beat were also slightly increased; Tracing No .2. When steady pressure was applied to this region, practically the same results were obtained, viz., first a perceptible decrease then an increase of 3 m. m. in blood pressure and a slight increase in rate and amplitude of heart beat. This was tried a second time with the same results, except the blood pressure raised only 2 m. m. The pressure (inhibition)was not applied evenly, therefore the tracing shows variations.

Osteopathic stimulation was also applied to the lower dorsal and upper lumbar regions. (Fig. 4.) This caused an increase in rate of respiration and heart beat. It also caused a decrease of 10 m. m. in blood pressure. This was followed by a marked decrease in rate of respiration; the rate of heart beat, however, continuing to increase. The blood pressure increased after stimulation was removed.

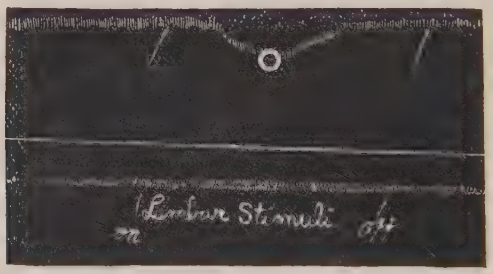


Fig. 4.

Dog No. 6. In this case the effects of manipulation and pressure in the lower cervical region was demonstrated: Manipulation caused an increase in blood pressure of 5 m. m.; rate and amplitude of heart beat remaining unaffected. Pressure caused an increase in blood pressure of 2 m. m.; rate and amplitude of heart beat remaining constant.

Dog No. 7. This dog was used to demonstrate the results of manipulation in the upper dorsal. In this instance the results were especially good, in that the blood pressure rose 3.5 m. m. and continued above normal for 2.5 minutes. When inhibition was applied to this region, a very marked decrease was obtained, but when two or more attempts were made to confirm this result, a slight increase instead was produced.

Summary and Conclusion

The nature of this work is such that it has seemed advisable to state some of our general conclusions from the results of this series with a discussion of the various theories which had been given above. By this means we have avoided much repetition. This final statement of our results will therefore be given briefly and with little comment.

The above results relative to stimulation and inhibition have been reported in detail on seven of the animals for the purpose of showing the reason for the following conclusions:

1. That osteopathic manipulation to the mid or lower cervical and upper dorsal regions causes an increase in blood pressure and as a rule a slight increase in rate and amplitude of heart beat.

2. Osteopathic manipulation when applied to the mid and lower dorsal or lumbar regions produces a reduction of systemic blood pressure while the respiration and heart beat remain unaffected or are slightly increased.

3. We have not been able to demonstrate in this series of work that there is any essential difference between osteopathic stimulation and inhibition when applied to the same area of the spine.

4. That osteopathic manipulation or inhibition when applied to spinal regions and which does not effect a cor-

rection of any structural perversion is not always followed by specific effects.

5. That osteopathic manipulations when applied to various regions of the spine are neither specifically stimulatory or inhibitory unless by such treatment a correction of some structural perversion is effected.

6. In most animals all kinds of manipulative treatment are to some extent stimulatory in nature, except pressure which is applied over nerve trunks or over the so-called "peripheral centers" for long periods of time. This may be explained by the law, "over-stimulation equals inhibition," but we question if this applies to manipulation of the spine.

7. That treatment of a certain spinal area in most cases is followed by physiological effects which depend upon the function of the nerve supply of structures innervated from these spinal segments; as, for example, the almost constant increase in blood pressure obtained from manipulation of the lower cervical and upper thoracic region. It may be argued that the quite constant results obtained from certain so-called inhibitory treatments, such as that used in diarrhea, would tend to conflict with the results given above, but we would remind the reader that the function of the splanchnic nerves, to the intestines is normally that of inhibition to the peristalsis, and therefore decreased peristalsis would result from stimulation rather than from inhibition.

A STUDY OF THE EFFICIENCY OF CARBOLATED GLYCERINE AS USED IN THE PURIFICATION OF VACCINE VIRUS[1]

SERIES No. 8.

BY ALBERT R. BELL AND EDWARD WARD.

The object of the following experiments has been to determine the efficiency of Carbolated glycerine as a germicide to the various organisms found in vaccine virus. Also to determine whether pathogenicity of the organism was decreased, in any way, by being passed through such a solution.

LITERATURE.

Before taking up for consideration the technique used in our experiments it might be well to briefly review the methods employed by the various vaccine manufacturers in the purification of their products. The animals used in the production of the vaccine virus, after having the posterior surface of their abdomen shaven, are inoculated with seed virus. This seed virus is obtained from the exuding serum of a vesicle of a vaccinated child, five days after inoculation. Bone slips, which are charged with this serum, are used in the inoculation of the animals. On the fifth or sixth day after the inoculation of the animals the shaven area of each is thoroughly cleansed with sterile water and cotton, and the crusts on the developed vesicles picked off.

The pulp remaining in the vesicles is then removed by means of a sterile steel curette and placed in an antiseptic container. To the pulp is then added a solution of carbolated glycerine (glycerine 50 parts, distilled water 49 parts, carbolic acid crystals 1 part), in the proportion of one part of pulp to four parts glycerine. The more watery the pulp the less carbolated glycerine is added. The pulp and glycerine are then thoroughly mixed and the emulsion so

1 Published first in the Journal of Osteopathy, June, 1911.

produced is placed in sterile vials, or in capillary tubes; and is then ready for the market. The only variation from the above method of purification is the technique adopted by some German manufacturers who claim that pure glycerine is in itself sufficient to kill any contaminating organisms.

The value of an antiseptic is always relative, its inhibitory action varying with the resistance of the bacterium upon which it acts. One theory of the destruction of bacteria by means of chemical substances is that the germicidal action is due, not to a physical reaction, but to a chemical change in which the ions of the antiseptic enter into direct chemical union with the protoplasm of the bacterium. By this union a new inert chemical compound is formed. In speaking of this reaction Abbott says in his eighth edition of Principles of Bacteriology, "There is an increased energy of the reaction with elevation of temperature. Just as in many other chemical phenomena the intensity and rapidity of the reaction becomes greater under the influence of heat, so in the process of disinfection the combination between the disinfectant and the organism to be destroyed is much more energetic at a temperature of 37° C. than it is at 12° C. to 15° C." He further says, "When it is desirable to use chemical disinfectants in the laboratory satisfactory results can usually be obtained from carbolic acid in solution. A 3% or 4% solution of commercial carbolic acid in water requires longer for disinfection; but it is at the same time open to fewer objections than are solutions of the inorganic salts; though, here too, we find a somewhat analogous reaction between the carbolic acid and the proteid matters. Under ordinary circumstances its action is complete in from twenty to thirty minutes. It is not reliable for the disinfection of resistant spores, such for instance as those of B. Anthracis." Carbolic acid acts as an antiseptic in 1% to 3% solution and as a disinfectant in higher concentrations. "A 3% solution will sometimes kill the spores of Anthrax Bacillus after two days. In the absence of spores the Anthrax Bacillus is destroyed by a 1% solution in one hour. The less persistent pyogenic cocci are destroyed rapidly by a 2% solution." (William's Manual of Bacteriology, fifth edition by Bolton.) Rickett's work on

Immunity and Serum Therapy, published by the American Medical Association Press, says, "Glycerinated lymph has many advantages, the most important of which relates to the bactericidal action of glycerine by which the lymph is freed from pathogenic bacteria (e. g., streptococci), which in former times caused serious complications in vaccination," "Glycerin is supposed to destroy such organisms to a larger degree without, however, injuring the vaccine virus itself." He also says, "The bactericidal power of glycerine has been over-estimated, and while it kills pyogenic cocci within two weeks when kept at body temperature, such organisms may live for months in glycerine when in the ice chest; and of course our glycerinated virus is kept in the ice chest. Tetanus spores live for months in glycerine and glycerine has practically no neutralizing powers on tetanus toxin."

Methods and Technique.

Before beginning the experiments considerable time was spent in preparation of the necessary apparatus, etc., to be used in the work. Loeffler's blood serum media and peptone boullion were prepared and sterilized one hour daily at 85.° C to 90° C. for nine consecutive days. Solutions of carbolic acid (1% and 4%), in glycerine, and flasks of distilled water were autoclaved fifteen to thirty minutes daily at a pressure of fifteen pounds for eight consecutive days. All culture tubes, pipettes and other glassware were sterilized in a hot air sterilizer at 150° C. for one hour.

The pipettes were then placed in a solution of sulphuric acid and alcohol until ready for use, when they were thoroughly washed in sterile water. The technique adopted was: (A) The organisms were first cultured for a given time in peptone bouillon and stains made, to verify their presence. (B) Carbolated glycerine was then added to the peptone bouillon in sufficient amount to give a solution of carbolic acid, of a definite percentage. (C) After a given time one loop full of glycerinated bouillon solution was transferred to blood media and its growth noted and proved by staining.

The organisms in all phases of the experiment were kept in an incubator at a temperature of 37.5°C.

All transfers were made from the bouillon solution and not from the clumped organisms which frequently appeared on its surface.

All dilutions were expressed in terms of percentage of carbolic acid.

The technique of dilution was: The organism was inoculated into 5 c. c. of peptone bouillon, to which was added carbolated glycerine solution after growth of organisms had been determined. A 2% solution of carbolic acid in glycerine was used, also a 4% solution. Thus it can be readily seen that a mixture of carbolated glycerine and bouillon to the strength of 1% carbolic would contain approximately 50% of glycerine. Likewise the 2% carbolic strength. Also that the carbolic solution of the glycerinated bouillon to the strength of 1⅓% and 2 2-3% would contain approximately 66 2-3% of glycerine, and that the 1½% strength of carbolic acid would contain 75% of glycerine.

All dilutions were measured by means of graduated pipettes and each pipette used was discarded for resterilization, after every transfer.

The glycerine and carbolic acid crystals used in making the solutions were chemically pure and of the highest quality.

The organisms used in these experiments were those isolated by Dr. J. Deason from vaccine virus as described and shown by photomicrographs in Series No. 6. The results obtained for the individual organisms are tabulated below:

Organism No. 4.

April 27.—Organism inoculated into 5 c. c. peptone bouillon.

April 29.—Stains made from bouillon and organisms found. Carbolated glycerine added to strength of 1% carbolic.

May 1.—Organism transferred from bouillon to blood serum media.

May 3.—Vigorous growth on blood media noticed. Stains made and organisms found present.

May 23.—Organisms, which had been growing in carbolated glycerine since April 29th, were transferred to blood media.

May 24.—Vigorous growth noted on blood media inoculated the previous day. Stains made and original organisms found present.

May 4.—Carbolated glycerine increased to 1⅓%.

May 6.—Organism transferred to blood media.

May 8.—Growth noted on blood media, stains made and organisms found in excessive numbers .

May 7.—Carbolated glycerine increased from 1⅓% to 1½% carbolic.

May 10.—Suspension of organism in glycerinated bouillon transferred to blood media.

May 11.—Vigorous growth noted on blood media.

May 12.—Organisms proved present on blood media, by staining.

May 23.—Organisms, which had been in glycerinated bouillon since May 7th, were transferred to blood media.

May 24.—Vigorous growth noted on blood media.

May 14.—Organism was transferred to peptone bouillon from blood media, which blood media had been inoculated from a culture of 1½% carbolated glycerine.

May 15.—Vigorous growth noted on peptone bouillon inoculated the day previous. Dense scum of organisms was noticed floating on top of media.

May 17.—Carbolated glycerine added to strength of 2% carbolic.

May 19.—Blood media inoculated from culture in glycerinated bouillon.

May 20.—Abundant growth noted on blood media, eighteen hours after inoculation.

May 17.—Part of the tubes containing organisms, inoculated into peptone bouillon on May 14th (see May 14 and 15 of experiment with 2% carbolic), were diluted with carbolated glycerine to the extent of 2 2-3% carbolic.

May 19.—Blood media inoculated from bouillon suspension.

May 20.—Rank growth of organisms found present on blood media and identified by staining. (This blood medium culture was only eighteen hours old at time of examination.)

May 23.—Organisms growing in 2 2-3% carbolated glycerine since May 17th, again inoculated into blood media.

May 24.—Vigorous growth noted on blood media. Stains made and original organisms identified.

The morphological, staining and cultural characteristics of this organism remained constant throughout the experiment.

Organism No. 5.

April 24.—Organism inoculated into peptone bouillon.

April 26.—Stains made from bouillon and organisms found to be present. Carbolated glycerine added to strength of 1% carbolic.

April 29.—Transfer made from bouillon to blood media.

May 1.—Growth noted on blood media; stains made and organisms found.

May 23.—Organisms which had been growing in 1% carbolic since April 26th transferred to blood media.

May 24.—Vigorous growth noted on blood media and organisms identified by staining.

May 4.—Carbolated glycerine increased from 1% to 1⅓% carbolic.

May 6.—Transfer made to blood media.

May 8.—Stains made from growth, occurring on blood media, and organisms found present in large numbers.

May 7.—Carbolated glycerine increased to 1½% carbolic.

May 10.—Glycerinated bouillon suspension transferred to blood media.

May 12.—Vigorous growth on blood media noted; organisms identified by staining.

May 23.—Organisms which had been in 1½% carbolic since May 7th, were transferred to blood media.

May 24.—Vigorous growth noted and presence of original organism proved by staining.

May 14.—Organism transferred to peptone bouillon from blood media. (The blood media was originally inoculated from culture grown in 1½% carbolic.)

May 15.—Dense growth noted on peptone bouillon. Growth so vigorous that organisms formed a scum on top of media.

May 17.—The bouillon was glycerinated to the amount of 2% carbolic.

May 19.—Transfer to blood media.

May 20.—Vigorous growth noted on blood media after eighteen hours.

May 17.—Part of the tubes containing peptone bouillon cultures of May 14th (see above), were glycerinated to a strength of 2 2-3%.

May 19.—Transfer made to blood media.

May 20.—Rank growth noted on blood media; stains made and original organisms found present. (Eighteen hour culture.)

May 23.—Organisms, which had been in 2 2-3% carbolated glycerine since May 17th, transferred to blood media.

May 24.—Rank growth of organisms present on blood media. Stains of growth made and original organisms identified.

In this organism the culture characteristics remained constant throughout the experiment, while the morphological and staining characteristics were slightly altered; spores being developed, also a greater resistance to the common aniline stains.

Organism No. 6.

April 26.—Organism inoculated into 5 c. c. of peptone bouillon.

April 27.—Stains made of bouillon and organism found. Carbolated glycerine added to strength of 1% carbolic.

May 1.—Organism trasferred from glycerinated bouillon to blood media.

May 3.—Stains made of growth on blood media and organism present.

May 23.—Organism, which had been in carbolated glycerine since April 27th, transferred to blood media.

May 24.—Medium growth observed on blood media inoculated the previous day.

May 25.—Vigorous growth noted on blood media; organism spread over entire surface. Stains of growth made and original organism found.

May 4.—Carbolated glycerine increased from 1% to 1⅓%.

May 6.—Organism transferred to blood media.

May 8.—Stains made of growth occurring on media and organism identified.

May 7.—Carbolated glycerine increased from 1⅓% to 1½% carbolic.

May 10.—Transfer made from glycerinated bouillon to blood media.

May 11.—Vigorous growth noted on culture transferred the previous day.

May 12.—Stains made from growth and organism identified.

May 23.—Organism, growing in 1½% carbolic since May 7th, transferred to blood media.

May 24.—Medium growth on blood media inoculated the previous day.

May 25.—Vigorous growth noted on blood media; stains made and organism found present.

May 17.—Pepton bouillon which had been inoculated from growth on blood media (the blood media was originally inoculated from culture grown in 1½% carbolic) was glycerinated to strength of 2 2-3% carbolic.

May 19.—Glycerinated bouillon transferred to blood media.

May 20.—Vigorous growth noted on blood media.

May 21.—Stains made and original organism found.

May 23.—Organism, growing in 2 2-3% carbolic since May 17th, transferred to blood media.

May 24.—Scant growth on blood media.

May 25.—Growth on blood media had become vigorous. Stains made and organism indentified.

No change noted in morphological, staining or cultural characteristics.

Organism No. 17.

April 24.—Organism inoculated into peptone bouillon.

April 26.—Growth in peptone bouillon stained and organism found in abundance. Carbolated glycerine added to strength of 1% carbolic.

April 29.—Transfer made from glycerinated bouillon to blood media.

May 1.—Growth on blood media noted. Stains made and presence of organism verified.

May 23.—Organism which had been in 1% carbolic since April 26th, transferred to blood media.

May 24.—Vigorous growth observed on surface of media. Organism identified by staining.

The morphological, staining and cultural characteristics were unchanged.

Organism No. 18.

April 24.—Organism inoculated into peptone bouillon.

April 27.—Presence of organism in peptone bouillon verified by staining. Carbolated glycerine added to strength of 1%.

May 1.—Transfer made from glycerinated bouillon to blood media.

May 3.—Growth on blood media very evident. Stains made and organism found in great numbers.

May 4.—Carbolated glycerine increased from 1 to 1⅓% carbolic.

May 6.—Transfer made from glycerinated bouillon to blood media.

May 8.—Growth on blood media; stains made and organism found.

May 7.—Carbolated glycerine increased from 1⅓% to 1½% carbolic.

May 10.—Transfer made from glycerinated bouillon to blood media.

May 11.—Vigorous growth noted on surface of blood media.

May 12.—Stains made and organism found to be present.

May 14.—Growth on blood media (which had been transferred from 1½% glycerinated bouillon on May 10th), transferred to peptone bouillon.

May 15.—Vigorous growth of organism seen floating on top of bouillon. Stains made of growth and original organism identified.

May 23.—Organisms which had been in carbolated glycerine 1½% since April 27th, transferred to blood media.

May 24.—Vigorous growth noted on blood media. Stains made and original organism found.

No change in morphology, staining or cultural characteristics.

Organism No. 5 was grown in carbolated glycerine 1½% carbolic for twenty days, then retransferred five times to blood media, in order to free from the carbolic acid. A suspension of this organism was made in normal salt solution, to which a small amount of peptone was added. The animal used was a large rabbit weighing about two Kg. The abdomen was cleanly shaven and washed with soap and sterile water; then alcohol applied freely to the shaven area. About 2 c. c. of the suspension was injected into the animal by means of a pocket inoculation, and the puncture sealed with collodium. On the following day a lesion had developed at the point of inoculation. This lesion continued to spread until it reached a diameter of about 2½ inches. Large amounts of pus were produced in the lesion. Stains made from the pus showed a long bacillus with the same staining characteristics as the organism used in inoculation. The animal died one week after the inoculation was made.

Conclusion and Summary.

From the above data, taken from experiments on typical organisms, it may be seen that in no case did carbolic acid and glycerine in the strength used by vaccine manufacturers, and in higher concentrations, kill any of the contamination organisms. Neither did it inhibit their growth to any extent.

The fact that there is no vigorous growth of organisms in vaccine virus should be attributed to the low temperature at which the virus is stored and not to the antiseptic properties of carbolic acid and glycerine. The organisms used by us were cultured, in an incubator, at a temperature of 37.5°C., at which temperature carbolic acid acts best. Organisms whose growth at this temperature is not inhibited would be more immune at lower temperatures. Even the nonsporulative organisms were not acted upon to any degree.

The skin lesion produced by organism No. 5, after its growth in carbolated glycerine, was as extensive and developed just as soon as did lesions produced by the same organism, before treatment with this "antiseptic" solution.

Therefore, organisms subjected to treatment by carbolated glycerine do not seem to be attenuated in any manner, nor is their pathogenicity diminished, for when placed on suitable media vigorous growth immediately begins and their virulence is as marked as before.

We are greatly indebted to Dr. Deason for his timely suggestions and valuable assistance in these experiments.

SOME IMMEDIATE EFFECTS OF DORSAL LESIONS ON VISCERAL REFLEXES[1]

SERIES No. 9.

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While working on "movements of the alimentary canal" with the various classes that have gone through the Physiology Laboratory of the American School of Osteopathy during my connection with it, I noticed an occasional animal whose reflexes were diametrically opposite to what had been designated as normal—i. e., a reflex inhibition of peristalsis as a result of stimulation of a peripheral spinal nerve. In seeking an explanation of this I examined the spine and invariably found a lesion or lesions, in the splanchnic region, more likely at the seventh, eighth or ninth dorsal, although some were above and some below this.

These lesions[2] were generally in the form of rotations (an occasional scoliosis was found) and rather pronounced—i. e., were visible after removal of the skin and fascia and were easily reduced in the dead animal (a similar lesion is occasionally found in an animal that reacts "normal"). This offered a plausible explanation to me and in an endeavor to prove or disprove its relation to results obtained I undertook the following experiments:

PROBLEMS.

1. May a spinal lesion affect the normal spino-sympathetic reflexes, if so, does it inhibit or accelerate the action of the region involved?

2. Is this action constant?

3. Is only one or are all functions of the involved nerves affected?

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1 I am greatly indebted to Dr. J. Deason for his encouragement, aid and valuable suggestions.

2 It has been suggested that a similar lesion might be produced by the pre-anesthetic struggles of an animal. While these are occasionally rather violent, I know of no authentic case and, although not impossible, it is certainly not a frequent occurrence.

Literature.

Unfortunately little or nothing can be found in the literature that has even an indirect bearing on this work. All laboratory men who have worked any number of animals know that occasionally one is found whose reflexes do not react in accordance with what they are trying to demonstrate, or in other words, do not follow the general physiological principles outlined in our standard texts. In some experiments this is a source of great annoyance and has been variously explained to students and others as a lack of technique, individual variations and idiosyncracies on the part of the animal's nervous system, the general physiological state of the animal, fatigue, or the inertia of the part involved. While any one of the above may and probably does have something to do with a certain class of cases, particularly the transitory, they, as vital force and similar phrases, are much abused and too frequently used to bridge over our ignorance of a very important subject. It has been my experience that if bony lesions are sought for in those animals in which erratic results are constant or predominate,[3] they may be found.

I have tabulated the physiological literature that might have a bearing on this work in a previous article,[4] to which I will refer the reader, and have shown in the same article that partial or complete blockage of the splanchnic nerves would allow a peripheral irritation ordinarily spent over the splanchnics to affect their opponent, the vagus; and in another article[5] (in association with Dr. Deason) how a slight resistance to the respiratory impulse in the phrenic nerve would cause it to cross in the hemisected cord and affect the nerve of the hemisected side.

Methods.

Animals: Dogs, 14; cats 1. Anesthetic: Ether given by means of head mask, except in the first two or three cases, when the usual tracheal method was used. The

3 It must not be forgotten that reference is here made to reflex efforts where the element of resistance to the impulse (partial block) may divert it to another path.

4 Series No. 5.

5 Series No. 3.

mask was used because it lessened the exposure and trauma due to the operation. The anesthetic was in all cases constant and deep.

A window was made in the abdomen sufficiently large to observe the movement of the stomach. Care was taken to avoid undue exposure of chilling of the animal. The abdomen when opened was filled with warm normal NaCl solution 9 per cent. Nerves stimulated, sciatic and in some cases a cord of the brachial plexus. Occasionally at the end of the experiment the intact vagus and peripheral end of the sectional splanchnic were stimulated as a control.

Stimulation used: medium strength faradic current for one minute. Blood pressure tracings when taken were from the brachial artery with the usual manometrical method. In animals that did not relax well the abdominal muscles were sectioned. All animals were controlled before lesioning.

Lesions.—The animals in all cases were first normalized,[6] then while the anesthesia was deep, traction was applied to the caudal part of the body with the cephalic end fixed, or vice versa, then the body flexed and rotated with the point of lesion fixed.

Results.—It must be borne in mind that only the immediate[7] effects of the lesion are dealt with in this article.

In animals that reached normally before lesioning, stimulation of a peripheral spinal nerves (generally the sciatic) after lesioning caused a peristalsis of the stomach appearing in some cases almost immediately, in others from forty to sixty seconds after application of the stimulus.

EXPERIMENT NO. 3 ON DOG.

Anesthetic; ether by cone.
11:30 both sciatics ligated and sectioned;
11:33, cannula in brachial artery;
11:35, stomach exposed;
11:35.30, abdomen closed;
11:37, abdomen opened and filled with warm normal NaCl solution;
11:40, spontaneous peristalsis in stomach, movement

6 This normalization consisted of testing out the reflexes to be studied.
7 From time of production for the following 30 to 100 minutes.

increasing. Right sciatic stimulated, anesthesia light. Forced respiratory movements caused by stimulation forced the stomach out of abdomen;

11:40.15, stimulus removed;
11:43, left sciatic stimulated;
11:43.40, peristalsis stopped, stomach relaxed;
11:43.50, stimulus removed;
11:46, stomach relaxed, no peristalsis. Right sciatic stimulated;
11:46.50, stimulus removed; stomach more flaccid;
11:50, abdomen closed and sutured.
11:53, Rotation 6th, 7th, 8th, dorsal;
11:53.10, abdomen opened;
11:54, left sciatic stimulated; insufficient anesthesia;
11:54.55, stimulus removed;
11:57, left sciatic stimulated;
11:57.50, stimulus removed, no effect;
11:59, right sciatic stimulated;
11:51.15, peristalsis started;
11:59.50, stimulus removed;
12:02, left sciatic stimulated;
12:02.40, peristalsis started (weak);
12:02.50, stimulus removed;
12:03.50, peristalsis stopped.
12:05, Right ant. crural ligated and sectioned;
12:08, right ant. crural stimulated;
12:08.45, peristalsis started;
12:10.20, stimulus removed;
12:11, peristalsis stopped .

EXPERIMENT NO. 5 ON DOG.

MARCH 16, 1912.

4:20, Etherized by cone;
4:25, sciatic exposed, ligated and sectioned;
4:26, abdomen opened;
4:30, right sciatic stimulated;
4:31, stimulus removed, stomach relaxed;
4:36, peristalsis in stomach for some time; right sciatic stimulated;
4:37, stimulus removed; stomach relaxed; peristalsis stopped;
4:38, spontaneous peristalsis;
4:38.30, right sciatic stimulated;
4:39, stimulus removed; no change in stomach.
4:40, Rotation lower dorsal region;
4:45, right sciatic stimulated; peristalsis started;

4:46, stimulus removed: peristalsis stopped upon removal of stimulus;

4:50, left sciatic stimulated;

4:50.30, peristalsis in stomach: right sciatic stimulated;

4:52, stimulus removed; no change;[8]

4:53, peristalsis stopped.

4:55, Brachial plexus exposed, nerve ligated and sectioned;

4:57, nerve of brachial plexus stimulated;

4:57.15, peristalsis started;

4:58, stimulus removed:

4:59, peristalsis stopped.

Dog killed; rotation dorsal (5, 6, 7, 8, 9, 10.)

The duration of peristalsis after removal of stimulus was very inconstant, stopping in some cases almost immediately, in others continuing for several minutes with but little tendency to stop. In these cases, re-stimulation of a sensory (the same or other) nerve caused an increase in the force of the peristaltic wave.

In some animals the production of the lesion started a peristalsis which showed no tendency to stop and was increased by stimulation of the central end of the sciatic. Direct stimulation of the peripheral end of the cut splanchnic in these cases always inhibited peristalsis and in some cases initiated a reverse peristalsis which occasionally ceased with removal of the stimulus, but generally kept up for a varied length of time. In one instance, where peristalsis was already progressing, stimulation of the sciatic nerve broke the interval and immediately initiated a peristalsis of increased amplitude.

I will take the liberty of making reference here to the literature on anti-peristalsis,[9] which at best is very brief.

Lyle[10] states that anti-peristaltic waves occur under abnormal circumstances; i. e., intestinal strangulation,

8 Nerve had been injured central to stimulation.

9 The question of anti-peristalsis has nothing to do with this series of experiments as ordinarily planned, but as it was observed several times during the experiments and an explanation of it sought for, it was thought well to make mention of it here.

10 Lyle, Manual of Physiology, page 160.

while rarely[11] in the presence of stricture of the pylorus, true anti-peristalsis of the stomach has been observed.

A center[12] for opening of the cardia has been located in the corpus striatum, the impulse reaching the stomach through the vagus; dilation centers are found in the upper portion of the spinal cord. The efferent nerves for these centers are the splanchnics and aortic plexus.

Reflex relaxation of the cardiac orifice can be induced by irritation of the sensory splanchnic fibers or the sciatic. A contraction of the pylorus accompanied dilation of the cardia; during vomiting the pylorus contracts and a wave passes up to the region of the cardia (Schaffer disputes this), and if long continued antiperistalsis of the duodenum is noted. Irritation of the central end of the vagus is capable of inducing vomiting; central vomiting ceases after destruction of the corpus quadrigemina, division of the anterior column of the cord or destruction of the spinal sympathetics that pass to the stomach.

Venosity of the gastric blood as a result of capillary dilation may cause peristalsis. Nasse states "that the inhibitory fibers are readily exhausted by venous blood and that the splanchnic motor fibers are excitable for a longer time, inasmuch as stimulation of the splanchnics after death causes a peristalsis."

The peristalsis as the result of venosity of the blood, then, may be due to either the tonic activity of the motor fibers after removal (block) of the inhibitories, a reflex stimulation of the motor fibers; or a stimulation of the parts initiated by the environmental changes brought about by the physical, (changes in osmotic pressure and gaseous tension), and chemical alterations in the blood stream incident to its stasis. The importance of this cannot be over estimated.

EXPERIMENT NO. 8.
MARCH 30, 1912.

Large collie.
2:00, Etherized;
2:04, respiration ceased; artificial respiration began;

11 Landois, Textbook on Human Physiology, 10th edition, page 340—2.
12 Landois, Textbook of Human Physiology, 10th edition, page 281—2.

2:06, artificial respiration stopped; breathing normal;

2:16, left sciatic exposed, abdomen opened;

2:20, left sciatic ligated and sectioned;

2:30, right sciatic exposed;

2:31, right sciatic ligated and sectioned;

2:34, right sciatic stimulated; respiratory movements violent;

2:35, stimulus removed; respiratory movements deep but not forced; anti-peristalsis in pyloric and prepyloric part of stomach, interval 16 seconds;

2:38, reverse peristalsis weaker; right sciatic stimulated;

2:39, amplitude of reverse peristalsis increased, interval unchanged; stimulus removed;

2:45, anti-peristalsis is still present;

2:46, stimulus removed; strong anti-peristalsis;

2:47, respiration stopped; artificial respiration given;

2:48, artificial respiration stopped; breathing normal.

2:55 Lesioned[13] in mid-dorsal; reverse peristalsis still present;

3:02, right sciatic stimulated; force of reverse peristalsis at first increased, then decreased;

3:03, stimulus removed;

3:06, right sciatic stimulated; reverse peristalsis increased;

3:07, stimulus removed.

3:07, Neck opened;

3:08, right vagus exposed;

3:08.30, anti-peristalsis stopped, peristalsis started;

3:09.30, stimulus removed;

3:10.30, left sciatic stimulated anti - peristalsis started;

3:11.30, stimulus removed;

3:13, anti-peristalsis still present; right vagus stimulated; anti-peristalsis stopped and peristalsis started;

3:14, stimulus removed;

3:15, right sciatic stimulated. (Nerve in poor condition);

13 This animal's spine was very irregular in the mid and lower dorsal region; several of the vertebræ being rotated in opposite directions. It was a full blood Collie and sold to the laboratory because it was irritable when its back was touched, and as its owner put it, "No good, and was worrying the life out of him."

3:16, stimulus removed; no respiratory effect, no change in peristalsis. (Inspection showed that the nerve had divided high up and only the popliteal branch had been used);

3:17, peristalsis still progressing; peroneal branch of right sciatic stimulated;

3:18.25, anti-peristalsis started;

3:18.40, stimulus removed.

3:30, Left splanchnic ligated and sectioned; reverse peristalsis stopped, weak normal peristalsis began;

3:31, perihperal end of left splanchnic stimulated;

3:31.20, anti-peristalsis started;

3:32, stimulus removed;

3:36, right vagus stimulated; anti-peristalsis still present;

3:36.50, anti-peristalsis stopped, peristalsis started;

3:37.30, stimulus removed;

3:38, left splanchnic stimulated ;

3:38.20, peristalsis stopped and anti-peristalsis started;

3:38.20, stimulus removed;

3:40, left vagus exposed and stimulated; anti-peristalsis still progressing;

3:40.15, anti-peristalsis stopped;

3:40.20, strong peristalsis started;

3:40.55, stimulus removed;

3:41, peristalsis still going on; left splanchnic stimulated;

3.42.30, anti-peristalsis started;

3:43, stimulus removed; animal killed.

The results in this experiment were, in my opinion, due to old lesions. The inhibitory fibers being blocked and the anti-peristalsis being probably initiated by an action of the splanchnic nerves. The blood pressure in all cases was increased, the increase being uniformly greater before production of the lesion than afterwards. It may seem at first sight that this is inconsistent with the other results, but after careful consideration of the location of the lesions (below the cardia-accelerator region) and the function of the nerves involved and their general reflex responses, it will be more easily understood.

The lesion from its location affecting the reflex irritability of the splanchnics diminishing their visceral activity and to some extent their vaso-motor for the gastric and

omental vessels were visibly dilated after production of the lesion, while the cardio-accelerator and vaso-motor fibers of the thorax and extremities, or the vagi, would prabably not be affected, giving a struggle between the various components of the so-called circulatory nervous system. That portion of it tending to maintain bodily blood pressure winning agaist the odds of a crippled splanchnic system and a reflexly excited vagi. This gives a very nice example of a struggle between two systems and the separation of the reflex functions of an individual nerve. The more irritable and less resistant functions according to the habits of the organisms predominating.

Experiment No. 13.
April 9, 1912.

Medium sized dog.

4:20, Right brachial plexus isolated and nerve sectioned;

4:25, cannula in left brachial artery;

4:26, abdomen opened;

4:29, isolated nerve of brachial plexus stimulated;

4:29.20, peristalsis started;[14]

4:30, stimulus removed, peristalsis stopped immediately;

4:31, nerve of brachial plexus stimulated;

4:32, stimulus removed, stomach relaxed.

4:35, Lesioned in mid-dorsal region; peristalsis started shortly after production of lesion;

4:45, nerve of brachial plexus stimulated; force of peristalsis increased;

4:46, stimulus removed;

4:47, peristalsis decreased;

4:47.30, stimulus applied; peristalsis increased;

4:48.30, stimulus removed;

4:50, peristalsis stopped;

4:51, stimulation of brachial plexus;

4:51.30, peristalsis started ;

4:52, stimulus removed; dog killed.

Summary.

1. Stimulation of the central end of the sciatic or branch of the brachial plexus after lesion (rotation) in the

14 This animal's upper dorsal region had been manipulated before this experiment began which explains the peristalsis resulting from this stimulation (no palpable lesion had been produced).

mid or lower dorsal region causes a peristalsis in the stomach[15] and a minimal rise in blood pressure, which may or may not stop on removal of the stimulus. If a peristalsis is already progressing, this stimulus will increase its amplitude.

2. Production of a lesion is sometimes sufficient to produce a persistent spontaneous peristalsis.

3. An anti-peristalsis is occasionally observed, which is apparently due to an action of the splanchnic nerves.

Conclusions.

An acute lesion[16] will affect the normal spino-sympathetic reflexes. This action is inhibitory to the function of the parts involved.

The fact that a reverse peristalsis was obtained in some cases and the same effect preceded by a vaso-constriction and viscero-dilation was produced by stimulation of the peripheral end of the splanchnic nerve would lead one to think that this might affect all or only a part of the functions of the nerves involved or if such a thing be possible a perverted action of the involved nerves. This action surprisingly constant,[17] although it varies greatly in degree.

15 Other regions were not observed.
16 Rotation in splanchnic region of spine.
17 Being inconsistent in but two cases and absent in one, where, although there had been considerable manipulation of the parts, there was some doubts as to the existence of a lesion.

SOME IMMEDIATE EFFECTS OF BONY LESIONS ON VASCULAR REFLEXES

Series No. 10.

J. Deason, D. O. and C. L. Doron, D. O.

The purpose of this series was to determine the effect upon dorsal and lower cervical lesions upon:

1st, blood pressure; 2nd, rate and amplitude of heart beat.

Methods Employed.

Animals used, dogs nine, cats two. Anesthetic, ether given by means of a tracheal cannula, and in all cases deep and constant. The sciatic nerve was sectioned and stimulation applied to the central end by a medium faradic current. The blood pressure was taken from the carotid or femoral arteries by the usual manometrical method. Respiration was taken from a tambour attached to the tracheal cannula by a T-tube. Normal tracings were taken on all animals before they were lesioned.

Lesions were made by traction and rotation of the cephalic end, with the lower cervical or upper dorsal fixed. Most lesions were in the sixth and seventh cervical, the dorsal lesions being difficult to obtain and make permanent.

Literature.

Very little or no literature can be found on this subject, since only a comparatively small amount of work has been done along these lines. This series bears the same relation to vascular reflexes that series No. 9 does to visceral reflexes.

Results.

As has been proven many times, stimulation applied to the central end of the sciatic or any mixed or sensory nerve causes an increase in respiration, heart beat and blood pressure; the following is the table of the results obtained upon blood pressure, rate and amplitude of heart beat by stimulation applied to the central end of the sciatic:

BEFORE LESION.

Animal No.	Rate	Amplitude	Blood Pressure
1 Dog	Inc. 10%	Increase	Inc. 7 mm.
2 Dog	Inc. 10%	Increase	Inc. 6 mm.
3 Dog	Inc. 2%	Increase	Inc. 2 mm.
4 Dog	Dec. 4%	Increase	Inc 4.5 mm.
5 Dog	Dec. 2%	Decrease	Inc. 13 mm.
6 Dog	Inc. 2%	Same	Inc. 9 mm.
7 Cat	Inc. 2%	Increase	Inc. 9.5 mm.
8 Cat	Inc. 2%	Increase	Inc. 6 mm.
9 Dog	Inc. 10%	Increase	Inc. 8.2 mm.
10 Dog	Inc. 4%	Increase	Inc. 4 mm.
11 Dog	Same	Same	Inc. 4 mm.
Average	Inc. 2.9%	Increase	Inc. 6.6 mm.

AFTER LESION.

Animal No.	Rate	Amplitude	Blood pressure
1 Dog	No change	No change	Dec. 9 mm.
2 Dog	Inc. 8%	No change	Inc. 2.5 mm.
3 Dog	Inc. 1.8%	No change	Dec. 2 mm.
4 Dog	Inc. 2%	Increase	Dec 15.5 mm.
5 Dog	Inc. 2%	No change	Dec. 9 mm.
6 Dog	Dec. 1%	No change	Dec. 9.5 mm.
7 Cat	No change	No change	Dec. 7.2 mm.
8 Cat	No change	No change	Dec 4 mm.
9 Dog	Inc. 9%	No change	Inc. 3.5 mm.
10 Dog	No change	No change	Dec. 6 mm.
11 Dog	No change	No change	Dec. 2.6 mm.
Average	Inc. 2.3%	No change	Dec. 5.3 mm.

It will be noted from these results that before the lesion was caused the blood pressure was increased by stimulation to the central end of the sciatic; this increase ranging from two to thirteen m. m. with an average of six and six-tenths m. m. After lesion was produced, the same stimulation caused a decrease in blood pressure except in two cases. This decrease ranged from two to fifteen and five-tenths m. m., with a general average of five and three-tenths m. m.

In the two exceptions, the first (Dog No. 2.) the increase in heart beat was excessive, yet the blood pressure did not increase as much as before lesion. In the second case (Dog No. 9.), the heart beat was less than before lesion, but not enough to account for the change in blood pressure.

The rate of heart beat after lesion was not materially increased except in two instances. The amplitude, which before lesion was increased by stimulation, showed no increase after lesion, except in one case and that was very slight. All of these results were obtained within thirty or forty minutes after the lesion was made. After that time, the normal function was regained. When a sublaxation was obtained that was permanent the normal functions were not regained. These were only obtainable in small dogs. When a greater strength stimulus was used after the lesion than before, normal functions were obtained.

The following is a tracing showing the decrease in blood pressure due to stimulation of the central end of the sciatic after a lesion was produced.

Summary.

Stimulation of an afferent or mixed nerve caused a fall in blood pressure and a decrease in heart rate and amplitude, with a bony lesion in the region of the cardio-autonomics.

Conclusion.

The above results corroborate the findings obtained in Series No. 9; e. g., an acute lesion will affect the normal spinal sympathetic reflexes. This action is an inhibition to the functions of the parts involved. That the fall in arterial pressure was not due entirely to the rate and amplitude of heart beat can be seen from the results obtained. Stewart states: [1]"freezing of the cord in the lower cervical region

1 Sixth Edition page 167-8.

causes a marked fall in blood pressure, due to loss of vasa constrictor tone." May this decrease in blood pressure, as a result of osteopathic lesion, not be caused by the block of the vaso-constrictor fibers in this region, causing a loss of tone in the artery walls and a corresponding fall in blood pressure? It is also possible that the stimulus, unable to be communicated to the heart and blood vessels through the nerves of the lower cervical and upper dorsal regions, reach these structures by way of the vagi, retarding the heart action and causing a vaso-dilation.

Effects of Osteopathic Lesions Artificially Produced, Not Due to Spinal Shock.

It has been suggested by certain research workers in physiology in the regular medical schools that the results obtained from the produced lesions in animals by osteopathic workers might be due to spinal shock. The physiological meaning of "spinal shock" is that there are certain well marked and far-reaching disturbances of the central nervous system which result from trauma to or partial or complete section of the spinal cord. There is no reason for discussing here the various theories of spinal shock, but we shall try to show that the results obtained by us could not be explained by this phenomenon.

1st. The osteopathic lesion affects particularly the nervous system supplying visceral structure (spinal autonomics), the skeletal musculature being less often affected. Just the opposite to this occurs in spinal shock; viz., the skeletal muscles are most often involved. Sherrington states as follows:

"It is noteworthy that spinal shock takes effect on just those which waste when the synaptic nervous system is destroyed, namely, the skeletal muscles. When the primitive diffuse nervous system, the nerve net exists as in the visceral and vascular musculature, neither *spinal shock* nor atrophy occurs consequently to spinal transection and after total transverse lesion of the cord in man the depression of function of skeletal musculature is profound and practically permanent. On the other hand, the depression of visceral function seems hardly greater in man and the ape than in rabbit or frog."

2nd. Quoting again from Sherrington, "The shock takes effect almost exclusively in the aboral direction," which fact has been corroborated by most workers on this subject. On the other hand, the effects of osteopathic lesion may and, as a rule, will involve structures on either or both sides (cephalic and caudal to the point of vertebral separation) equally.

3rd. Spinal shock materially affects the blood pressure, causing a marked decrease and destroys the vaso-motor reflexes. Sherrington states: "When, in the dog, complete transection of the spinal cord, through the eighth cervical segment is practiced, a severe fall in general arterial blood pressure ensues and vaso-motor reflexes cannot be elicited."

The effects of the bony lesion produced in this area (References Series Nos. 2, 5, 7, 9) are, as a rule, just the opposite to this; viz.: That an increase in blood pressure and often an increase in rate and amplitude of heart beat result. The production of the lesion, that is, the possible effect or effects of manipulations used by us or the "strain" on the nervous system following these manipulations, could not be due to spinal shock because no marked fall in blood pressure has ever been found, and the vaso-motor reflexes are never completely destroyed. The fact that lesion or "spinal strain" in some areas of the spine produces an increase in blood pressure, while in other areas the opposite effect is produced, and the fact further, that no such effects are obtainable from spinal shock, again differentiate them.

4th. Paralysis, partial or complete, of certain muscles or groups of muscles, according to the extent of the lesion, is common in spinal shock. This is not true of osteopathic lesions. Of all the animals operated in this laboratory (about 140 dogs, cats and monkeys), not a single animal has ever shown any signs of paralysis. There was often tenderness about the affected part, but no symptoms of direct injury to the cord, and therefore no symptoms comparable to spinal shock. Extreme care was always exercised to not produce complete luxations, and there was never a case of bony fracture, ligamentous tear or complete luxation produced from our attempts to produce subluxations

or what may properly be termed osteopathic bony lesions. We have, of course, not obtained functional disturbances from every attempted lesion, but by far the greater number of such attempts have been followed by functional disturbances, and this could not have been due to spinal shock.

5th. The blood pressure effects from spinal bony lesion last several minutes, after which (if the lesion is only a spinal strain, i. e., if it is not a permanent subluxation) it returns to normal. This effect is somewhat similar to spinal shock, except that the time necessary for normalization is much longer. If the shock is due to complete transsection, several days are necessary for recovery. It might be argued that because the higher animals, man included, are more susceptible to spinal shock and recovery occurs slower, that in the human the effect which we hold as being the result of bony lesions could be due to spinal shock. This, we believe, is hardly tenable for the following reasons:

6th. In case of spinal shock, recovery of the structures supplied by the autonomic nervous system, visceral structures, occurs, which varies directly with the time and inversely with the phylogenetic developmental stage of the animal in question. On the other hand, as a rule, the effects of a permanent bony lesion increase with time. That is, in case of lesions of long standing, the perversion of physiological effects and the extent of pathological change is also increased.

7th. Spinal Shock and Spinal Strain: Since the phenomena of spinal shock are insufficient, what is the explanation of perversion of certain physiological functions following slight subluxations of the vertebræ and other joints? We expect to offer some suggestions in answer to this question after the results of all of our work of this year have been published and the results have been summarized. With the experimental information which we now have at hand it is safe to say that subluxations, due to trauma, muscular contractions, decreased tone in ligaments and muscles about the point, etc., may be capable of producing widely different effects. The first, the subluxation due to trauma is comparable to the artificial bony

lesion, and this we may say produces its effects by spinal strain. By spinal strain is meant the effects on the nerves in the immediate relation with the joint or joints involved. The stretching or compression of the joint structures might, by mechanical stimulation to either the efferent or afferent nerve elements, produce an increased activity of these fibres or nerve trunks. This, if the perverted structural relations are not permanent, would be temporary and a corresponding temporary inhibition or decreased functional activity of the nerve elements would follow, which lasts for varying lengths of time, after which normal functional activities of the nerves may be demonstrated. The fact that a temporary increase in blood pressure, etc., followed by a decrease, usually follows such manipulations tends to substantiate this theory. This explanation alone, however, is hardly sufficient for a complete explanation of all the results that follow "spinal strain."

What, for example, is the explanation of the decreased activity of the efferent nerves from segments of the spine which are so lesioned? Why are the blood pressure, heart beat, etc., not increased by stimulation of the central end of an afferent or mixed nerve after a "spinal strain" has been produced in the upper thoracic region as much before? Why do not the splanchnics inhibit peristalsis of the intestine from stimulation of a sensory nerve after lesion in the mid or lower thoracic as they almost invariably do before such "spinal strain" was effected?

The fatigue of the nerve elements may and probably do have much to do with this, but we believe the disturbance of both the afferent and efferent vascular elements play a more important part. It is known that the functional activity of the neuron varies directly with the arterial supply and the venous drainage. This is readily understood when we consider the nerve cell as any other cell and that it must have oxygen and other food elements from the blood that it may be able to function normally. Furthermore, it must have a good drainage, that its carbon dioxid and other products of metabolic waste may be removed. As Sherrington so excellently put it: "In the first place, nerve cells, like other cells, lead independent lives,—they breathe, they

assimilate, they dispense their own stores of energy, they repair their own substantial waste; each is, in short, a living unit with its nutrition more or less centered in itself. Here then, problems of nutrition, regarding each nerve cell and regarding the nervous system as a whole, arise comparable with those presented by all other living cells." This explanation as offered here relative to the blood supply for the decreased activity of nerve tissue was not borrowed from the old stock answer given by most osteopaths when asked how the lesion produces its effect. It is not an answer given from hasty evidence or none, as we often hear the answer "Nature does it." It is not a guess at which we have blindly jumped or a shield behind which we may conceal our supreme ignorance, but a scientific conclusion at which we have arrived after having given careful consideration to the experimental evidence at hand.

Drs. McConnell and Farmer have found that the structures about the joint after such lesions were produced were much congested and we have found the same to be true. We have found further that it is not possible to obtain normal efferent effects by afferent stimulation until long after the immediate effects of the "spinal strain" have seemingly ceased. We have found that the stimulation of the efferent nerve trunk after stimulation produces normal functional effects as it did before lesion, therefore the trouble must lie within the cord or other seat of nerve cell origin. Just here, by way of explanation, we should say by this the explanation of the decreased functional activity of the spinal autonomics from reflex stimulation after spinal lesion, as has been demonstrated in this and a preceding series (No. 9), depends upon the structural and functional differences between the conducting mechanism in nerve trunks and the reflex arcs of the cord, particularly the synaptic arc.

The conductivity in the reflex arc presents many characteristic differences from that of nerve trunks, as follows: "Slower speed as measured by the latent period between application of stimulus and appearance of end-effect, this difference being greater for weak stimuli than for strong." **** "Fatiguibility in contrast with the com-

parative unfatiguibility of nerve trunks." **** "Much greater dependence on blood circulation, oxygen (Verworn, Winterstein, V. Baeyer, etc.)" It is, then, this intercellular connecting mechanism, that which carries the energy from axon to dendrite within the gray matter of the cord and is transmitted to or serves to excite to activity the intracellular energy of the efferent neuron, which is most affected and which offers resistance to the passage of impulses in reflex block. It has been shown (Series Nos. 2, 5, 8 and 9) that this condition, which we may now call reflex block, is maintained as long as the structural perversion (bony lesion) is maintained, and that a return to normal always results from five to sixty minutes after the vertebral perversion has been released. This time allows for the normalization of the blood supply to the synaptic portion of the reflex arc. We are, of course, referring to the immediate effects of experimental bony lesions and not to chronic lesions.

By this explanation we do not mean to exclude all possible effects of direct nerve stimulation by mechanical pressure to the nerve trunk or to sensory endings in or about the joint. We know of no experimental evidence to show that direct nerve stimulation is not a possible explanation of certain phenomena following bony lesions. But this will be discussed in another series in which some work has been done along this line.

INNOMINATE LESIONS

J. Deason and C. P. McConnell.

Series No. 11.

That subluxations of the innominate bones are common structural perversions which are causative factors of various functional disturbances has been known and quite well understood by osteopathic physicians for a great many years. And the so-called recent information gained by certain research workers, viz., that the union of the ilia with sacrum are true synchondroses, is no new discovery to the osteopath. As evidence of this we quote the following from the fourth edition of "Hulett's Principles of Osteopathy": "Bear in mind the fact that the sacro-iliac articulation is an arthrodial or gliding joint and in most younger individuals is supplied with the typical structures, including the synovial membrane and fluid. This suggests a fair degree of movements, etc." The manner in which the functional disturbances are produced, that is, the nature of the perverted physiological changes which result from such lesions has certainly not been satisfactorily explained. Some physicians have held that the result is due to pressure upon the nerve trunks at the point where they pass over the synchondrosis. Others claim that it is due to reflex, and so on. It was for the purpose of throwing some light on this question that this series of experiments has been done.

Literature.

We know of no results from animal experiments which have been done along this line, but the osteopathic literature is rich in case reports and various discussions as to the effect of such lesions, etc. During the past few years some work has been done along this line by certain medical physicians and the information gained has caused many of them to employ for the treatment of certain conditions methods which have long been in use by osteopaths. A good discussion of bony lesions (subluxations) of the pelvis may

be found in a book of recent publication on "Diseases of the Bones and Joints," by Goldthwaithe, Painter and Osgood, from which we shall have occasion to quote.

In calling attention to this book we do not wish to be understood that we consider Dr. Goldthwaithe a discoverer of this condition at all, for on the other hand, as Dr. Tasker puts it, "Of one thing I am certain, and that is, it was ancient history in our profession before Goldthwaithe brought it to the attention of his fellow M. D.'s" One is safe in saying that for many years the osteopathic profession has accepted as a fact the statement that the integrity of the pelvic joints is essential to a normal superimposed spine as well as normal functioning.

Methods Employed.

Normalization: Seventeen dogs were used for this series of experiments. These animals were normalized by keeping them from two to four weeks in cages, giving them a regular diet, observing their general condition, e. g., appetite, weight and consistency of feces, samples of urine were regularly taken and analyzed. When each animal had been kept for a sufficient length of time to know that it was in good condition, it was then lesioned.

Methods of Lesioning: A careful study was made of a prepared dog's skeleton and a few dissections of the joints of recently killed dogs were done that we might know how to produce the lesion. The animals were placed under deep ether anesthesia and the joint subluxated by strong rotation, using a leg and the crest of the ilium and applying the force in the plane of the articulation. The animals were now kept in separate cages and observed for from one to four weeks.

Results.

A few of the dogs showed lameness on the "innominated" side for a few days after the production of the lesion, but there was no paralysis. Nine of the dogs developed diarrhoea, which lasted from one to four days. In seven of the dogs there was a moderate glycosuria, varying from one-tenth per cent. to seventy-five hundredths per cent, and lasting from one to six days. But this did not occur in all the animals "innominated", nor was it either

severe or constant in those which did show these effects. The urinary findings, such as an increase in albumen for a few days after the lesion and in one case a constant increase in chlorids, was found, but no marked changes in specific gravity nor urea were noted. Forty-two complete qualitative and quantitative analyses were made before lesioning. After the lesion was produced, forty-one complete qualitative and quantitative analysis were made.

Post Mortem and Pathological.

Four of the animals which showed effects as stated above were killed five days after the lesion was produced and several of the sciatic nerves of both sides, including that part which passed over the sacro-iliac joint, were removed and kept for microscopic examination. The lumbar and lower thoracic part of the spinal cord was also kept. Post mortem examination of several of the other animals was made from a few days to two weeks after the lesion had been produced and in nearly every case it was found that a good subluxation had been produced and that the joints had remained in lesion.

Pathological Findings.

The following report is made by Dr. McConnell:

On January twelfth, I received the following nerve specimens from you for examination: Dog 1, Tube 1, lower spinal cord and cauda equina; Tube 2, upper sciatic on lesioned side in section; Tube 3, lower sciatic on lesioned side; Tube 4, lower sciatic on unlesioned side; Tube 5, upper sciatic on unlesioned side. Dog 2, Tube 6, lower spinal cord and cauda equina; Tube 7, sciatic on lesioned side; Tube 8, sciatic on unlesioned side.

I followed the Marchi method in the examination of the specimens. The tissues being placed in Muller's fluid by you as soon as autopsy, assured an early fixation.

I have made a large number of sections and have gone over the same several times. The following is noted: Specimens in Tubes 4, 5 and 8, negative; Tube 1, 2, 3, 6, and 7, slight pathologic involvement. The pathology is slight, but definite. Several medullary sheaths in groups and a few scatterings, have undergone a beginning parenchymatous degeneration. This is true in both the upper and lower sciatic sections, but changes are more pronounced, that is numerically, in the nerve groups just outside the

spinal cord on the right side. The sections of the spinal cord were not high enough to include these particular fibers.

There was a slight passive congestion in the sciatic nerve. No special lesion of the artery could be made out.

Summary and Conclusion.

It has many times been stated, but we believe never before demonstrated by experiment, that innominate lesions are directly responsible for various perverted physiological condition.

Hazzard has stated "that bony and ligamentous lesions of the pelvis are so significant from the osteopathic standpoint as causes of disease in the pelvic viscera, in the limbs or in the body above," and that "the general symptoms of said troubles are pelvic diseases, female disorders, backache, neck lesions, sciatica, lameness or paralysis of the lower limbs, etc." Much of the above has been demonstrated in this series. Lesions of the pelvic joints may result from abnormal physiological conditions of the pelvic viscera and conversely abnormal physiological functions of the pelvic viscera may result from bony lesions of the pelvis. We quote the following from Goldthwaithe:

"In any disease of the pelvic organs in which there is much circulatory disturbance, the joints become relaxed, as a part of the same physiological reflex noted in pregnancy and menstruation. While this is probably true, the converse is certainly true, namely, that if the pelvic joints become relaxed as the result of accident or disease, the lack of stability of the pelvic girdle, with the resultant weakening of the support of the pelvic organs leads to congestive disturbances in these organs, this in turn probably acting upon the joints, so that until proper treatment can be instituted, there exists a vicious circle of cause and effects. The bone surfaces are smooth or slightly irregular, so that the stability of the joint depends almost entirely upon the ligaments and muscles. This being the case, anything that leads to loss in the muscle or ligamentous tone, renders these joints more prone to strain, and as their stability depends upon soft structures, disturbances in the normal approximation of the bones must be more common and result from much less violence than in the other joints."

He might have added that such bony lesions, because of the above reasons, would be followed by great physiological disturbances. How can it be explained that these

bony lesions are responsible for such far-reaching effects? One theory is that direct injury is done to the nerve trunks. Quoting form Goldthwaite,

"Under such circumstances not only are the joint structures injured or strained, but the large nerve trunks which cross this articulation in front are frequently irritated. Anatomically, the sacral plexus of nerves, with some of the branches from the lumbar plexus cross just in front of the synchondrosis. This being the case it is not difficult to understand the fact that irritation of these nerves is possible."

That such pathological changes do occur has been shown by Dr. McConnell in this series of experiments. This explanation, however, can hardly account for the so-called reflex effect and general visceral disturbances which are so commonly found and which may result from very slight subluxations, because the pathological changes do not begin immediately.

Concerning these slight lesions, Goldthwaite explains that,

"This of course impairs the normal function of the joint, and because of the character of the articulations in the pelvic girdle, it is evident that if one joint is injured, each of the other joints must be somewhat strained, so that the disability resulting from even a slight luxation of one of the sacro-iliac joints may become very great."

Such lesions could of course be the cause of functional disturbances in various adjacent viscera by their effects on the efferent nerve supply, or either their afferent or efferent blood supply, but this theory is hardly sufficient to explain all of the conditions. What, for example, is the explanation of the extreme nervousness, menstrual disorders, intestinal disturbances, etc., which so often follow so soon after a slight lesion of the innominate has occurred and which has neither increased or involved other pelvic joints?

That such conditions may exist we have shown by experiment. We believe the explanation in such cases is wholly different. That reflex effects involving certain viscera, as has been mentioned above, could result from the stimulation of some afferent or mixed nerve by pressure or otherwise we can say that the theory at least seems tenable, when we recall that such reflexes have many times

been demonstrated. Many of these (they may be called spinal-visceral) reflexes are furthermore specific in action, such as, for example, the contraction of the uterus from mechanical stimulation to the perineum or direct stimulation of certain sacro-spinal nerves. Schaefer states that,

"In animals such contractures (of the uterus) are strongly excited by faradization of the central end of the first sacral nerve. As the excitation in these instances is not applied to the uterine tissue or to afferent nerve channels, the resultant uterine reactions must be induced reflexly."[1]

We think the above physiological facts are sufficient to explain how, in this series of experiments, such perverted physiological conditions as diarrhoea and the urinary changes which were obtained, might follow the subluxation produced, and how the pathological changes which have been shown to result, cause a continuation of the process.

We are indebted to Mr. C. J. Anderson and Mr. R. L. Shook for taking care of the first ten animals during this series of experiments.

1 A. E. Schafer's "Text-Book of Physiology," Volume II.

Book References.

Hazzard's "Principles of Osteopathy."
Hazzard's "Practice of Osteopathy."
Tasker's "Principles of Osteopathy," 1st, 2nd and 3rd editions.
A. E. Schafer's "Text-Book of Physiology," Volume II.
Louisa Burns' "Basic Principles."
Goldthwaite, Painter and Osgood, "Diseases of the Bones and Joints."

VERTEBRAL LESIONS AND OSTEOPATHIC THERAPY

Series No. 12.

J. Deason, D. O., A. R. Bell, D. O., and
T. L. McBeath, D. O.

The purpose in this series of experiments was to try the effects of osteopathic lesions on monkeys, and if possible, after functional disturbances had occurred, following the production of bony lesions, to determine the effects of corrective manipulations on these animals. Monkeys were selected for this work because of their closer resemblance, structurally and functionally, to the human species.

Literature.

Animal experimentation for the purpose of determining the effects of osteopathic bony lesions on functional disturbances, pathological changes, etc., has now been done on hundreds of animals and by different workers, the published results of which should be common knowledge to every student and graduate of osteopathy. The columns of this, as well as other osteopathic journals[1] have contained these reports for several years. We therefore need to make no detailed references to this work. This series, however, presents some new features of experimental work, which so far as we know, has never been tried before, viz., an attempt to relieve the functional disturbances which followed the production of the osteopathic bony lesion, by a correction of the artificial bony lesion which seemed to have caused the disturbance.

Since it has been demonstrated that functional disturbances can be produced by artificial bony lesions, why should we not hope to relieve the functional disturbances by the correction of these same lesions. We have always believed that if the bony lesion was the cause of functional

1 This refers to the Journal of the American Osteopathic Association, in which many of these series were first published.

disturbances, that this, if true, could be demonstrated on animals; and it has been so proven. Drs. Burns, McConnell, Farmer and others, besides those working in our laboratories here, have shown this, and while there are many minor differences of opinion regarding certain details, our general findings agree remarkably well, much better, in fact, than do the results of the various research workers in other schools of practice.

Experimental Methods Employed.

There were many difficulties attendant upon such a series of experiments, probably the greatest of which was the proper care of animals. Twelve monkeys were used, aged from two to three years. One was a very old monkey, and therefore almost valueless. Most of the animals were too young, as it was often difficult to get lesions to "stick," their spine being so cartilaginous. Some of our animals were in poor health when they arrived and died of either pneumonia or tuberculosis before they had been normalized. No animal which was found to be unhealthy was lesioned.

Care of animals.—Each monkey was kept in a separate cage, an iron frame covered with wire netting; the floor of which was of hardware cloth under which was a zinc pan for the purpose of draining the urine into containers. Each cage was 30x30x20 inches, which gave the animal plenty of room. These cages were cleaned regularly by washing with a hot water and steam hose. The animals were fed twice daily and the diet kept as regular as possible, which consisted of apples, corn, cabbage, parsnips, toasted bread, etc.

The greatest difficulty met with in the care of the animals was the proper heating and ventilating of the rooms in which they were kept. Heat was furnished by steam radiators and a large stove was also used during the coldest weather. It was often impossible to maintain a sufficiently even temperature and at the same time furnish plenty of fresh air. We believe this contributed to the pneumonia which caused the death of four animals.

Normalization.—Samples of urine were taken daily and analyzed. The character, consistency and amount of

feces were noted, the appetite was observed and the weight of each animal recorded. All animals were kept from four to six weeks under observation before they were lesioned.

Monkeys Nos. 2, 3, 4 and 10 died from pneumonia within three weeks after they were received, but only one other animal (monkey No. 11.) showed any symptom of disease during normalization, and this case will be recounted later.

During the normalization, all animals either remained constant or gained in weight except No. 11, which lost weight from 2,200 to 1,800 grams. This monkey had tuberculosis when received.

No. 1. Young Java monkey, increased in weight from 850 to 900 grams.

No. 5. Rhesus monkey, increased in weight from 1,545 to 1,625 grams.

No. 6. An old Ring-tailed monkey, increased from 1,765 to 1,800 grams.

No. 7. Ring-tailed monkey, remained almost constant in weight at 1,000 grams.

No. 8. Rhesus monkey, gained in weight from 2,000 to 2,400 grams.

No. 9. Ring-tailed monkey, increased in weight from 1,000 to 1,050 grams.

No. 12. Rhesus monkey, remained almost constant in weight at 2,400 grams.

The fact that these animals remained constant or gained in weight during the period of normalization shows that they had good care and were free from disease up to the time of lesion. There were no symptoms or signs of disease (other than No. 11. given above), except occasional variations in urinary findings, the reasons for which will be stated later.

Method of producing lesions.—The animals were placed under deep ether anesthesia and lesions produced by fixing the vertebra at the point desired and rotating the animal's body. In some instances it was only necessary to manipulate the processes of the vertebra between the thumb and fingers to effect rotation, but in most cases we tried to produce lesions which would involve two or more segments at the same time. All lesions produced were rotation. We were always careful in the production of lesions

to not cause sufficient trauma which could in any way produce a fracture or ligamentous strain; therefore no traumatic effects to the cord were ever produced.

Results.

The functional disturbances following lesion in each animal will be given under headings significant of the disorder produced, for the purpose of clearness. Nutritional disturbances, following lesions in the upper thoracic region:

Monkey No. 5. Lost in weight from 1,625 to 1,425 grams during four weeks following lesioning. After the lesion was corrected, this animal increased in weight to 1,520 grams in two weeks.

Monkey No. 7. Lost in weight from 1,020 to 900 grams during two weeks. Correction of the lesion was not tried. (See special note on No. 7.)

Monkey No. 8. Lost in weight from 2,400 to 2,075 grams during four weeks and regained to 2,225 two weeks after lesion was corrected.

Monkey No. 9. Showed a slight gain for one week and then lost from 1,050 to 925 grams during the three following weeks. Two weeks after correction of lesion, this animal gained in weight to 1,000 grams, its normal weight.

Monkey No. 12. Lost in weight from 2,400 to 2,112 grams during four weeks following lesioning, and regained to 2,150 two weeks after lesion was corrected.

Monkeys Nos. 1, 6 and 7. Were kept for control; i. e., they were kept un-lesioned on the same food supply in the same room with all environmental conditions the same. During all this time Monkey No. 1 showed a constant gain from 900 to 1,000 grams. Nos. 6 and 7 remained constant in weight.

This we believe controls the experiment quite well and the cause for this loss in weight of the four lesioned animals would seem to be the thoracic lesion. By reference to the above discussion on normalization, it will be seen that only normal animals were used and that those which had been showing a constant increase in weight during the period of normalization showed a marked decrease after lesioning. We should not, of course, be so hasty as to conclude that the upper thoracic lesions are always followed by loss in weight, nor would we ever assert positively that the lesions were responsible for the decrease in weight in

these cases. Too few animals have been tried and the test has not continued long enough to make positive statements.

INTESTINAL DISTURBANCES FOLLOWING THORACIC LESIONS.

Seven monkeys were lesioned, some in the mid and some in the lower thoracic region. Intestinal disturbances and variations in the urinary findings were noted after these lesions. The results of urinalysis will be given later. The intestinal changes only are to be given under this heading.

Monkey No. 1. Showed no symptoms at all that we could observe; there was no diarrhoea nor constipation at any time.

Monkey No. 5. The next day after lesioning this animal had a marked diarrhoea, which increased for one week, when the lesion was corrected. After correction of the lesion, the diarrhoea stopped and remained normal for a week, when the lesion was reproduced. This was followed by diarrhoea as in the first instance, except that it was more severe. Nine days later the lesion was corrected, and as before, this treatment was followed by an immediate cessation of the diarrhoeal condition. This monkey was lesioned the third time, twelve days later, which caused the same symptoms, but this time treatment seemed only to offer a temporary relief. We were never able to stop the condition, which grew constantly worse, until the animal was killed one month later. There was loss of weight during this time, but we think this was probably due to the extreme diarrhoeal condition, rather than any interference with systemic metabolism, as the animal's health was otherwise good.

Monkey No. 6. Showed no intestinal disturbances, but was only kept in lesion a few days. (See special discussion of Monkey No. 6.)

Monkey No. 7. Showed a slight diarrhoea for a few days only. Corrective treatment was not tried. (See discussion on No. 7 elsewhere.)

Monkey No. 8. Showed a slight diarrhoea the following day after lesioning. This continued so for fifteen days, when the lesion was corrected. The diarrhoea stopped and stools remained normal for a week, when the animal was re-lesioned. Diarrhoea again occurred, which lasted for a week and stopped after a second correction of the lesion. The diarrhoea was never severe in this animal, and there was a constant increase in weight during the entire time.

Monkey No. 9. Showed no diarrhoea or constipation after these lesions and the weight remained nearly constant.

Monkey No. 11. A severe diarrhoea developed in this animal after lesioning, and as in No. 5, immediately stopped after the lesion was corrected. This animal was lesioned in both upper and lower thoracic regions, but was not tried a second time. (See discussion No. 11. below.)

Monkey No. 12. After lesioning, this animal showed diarrhoea almost immediately, which continued for one week and stopped after correction of the lesion. The animal was re-lesioned seven days later, and a diarrhoea appeared which, though not so severe as in No. 5, continued for three weeks, when corrective treatment was followed by normal feces. This animal continued to gain in weight during the time of lesion. It was kept unlesioned for one month longer, when it was killed for pathological examination. No diarrhoea appeared during this last month and the weight increased in greater proportion than during the period of lesion.

Urinary Findings.

Samples of urine, free from feces and other contamination, were collected daily when obtainable. Urine was collected in clean graniteware receptacles and from these transferred to glass beakers for analysis. All samples represented a twenty-four hour elimination and were examined fresh. So far as the urine held out, the following tests were made, precedence being given to sugar, albumen, and urea, as the more important constituents:

1st. Any cloud present was tested for mucin, phosphates, urates, pus and bacteria.

2nd. Color was recorded according to Vogel's color scale.

3rd. The specific gravity was taken by means of a standardized urinometer and test jar.

4th. The amount of solids was estimated by the use of Haesser's factor (2.33).

5th. The chemical reaction was obtained by using both red and blue litmus paper. When alkaline, the alkalinity was determined whether due to fixed (sodium and potassium) or volatile (ammonia) salts.

6th. The amount of urea was determined by a Hinds-Doremus ureometer, and a freshly prepared solution of sodium-hypo-bromite. Hufner apparatus was also used on some of the animals.

7th. Albumen tests were made by Heller's nitric acid test and the acetic and heat test. Any traces shown by these methods were confirmed by Esbach's picric acid test. Quantitative tests were made by the Esbach twenty-four hour method.

8th. In the estimation of chlorids, a standardized 12½% solution of silver nitrate was used.

9th. Phosphates were determined by use of magnesium mixture.

10th. Sugar tests were made by Haine's, Fehling's and Benedict's tests. Quantitative tests were made by Einhorn's saccharometer, controlled by a tube of distilled water and by a tube of one per cent glucose solution. Sugar was reported in no case unless confirmed by both a copper reduction test and the fermentation test.

11th. Indican tests were made by means of Obermeyer's reagent and extraction by chloroform, the urine having been previously decolorized by a drop of lead acetate solution.

12th, Blood tests were made by means of old turpentine and a fresh tincture of guiac (Haine's blood test).

13th. Acetone tests were made by Legal's and Lieben's tests, the urine having been previously distilled with phospboric acid.

All tests were checked by control tubes of distilled water. The apparatus used, as beakers, tubes and other glassware, was carefully and thoroughly cleaned after use and stored in dust-proof lockers. Test tubes used for sugar tests were kept separate from the others and cleaned in nitric acid to remove any precipitate of copper oxid.

This aided to eliminate any fallacious reduction. All urine used in the tests was carefully filtered and in the reduction test for sugar, any albumen was removed by boiling and filtration.

Following is a summarized record of each animal used:

Monkey No. 1. Seven analyses, covering a period of five weeks, were made. During the time of normalization and on one day only was sugar found. This amounted only to slight traces and might be explained by the fact that an excess of bananas was given in the diet at this time, which seemed to produce alimentary glycosuria.

The lesion produced was in the mid-dorsal area of the spine. On the second day after the production of the lesion, sugar appeared in the urine and continued to show

for ten days. The amount present averaged one per cent. daily for the entire ten days.

Monkey No. 5. During the time of normalization, this animal showed an average of two-tenths of one per cent. sugar in its urine. At the same time, the monkey gained one hundred grams in weight, which would tend to show that the glycosuria was of the alimentary type, since in pathological glycosuria loss of weight invariably occurs.

A mid-dorsal lesion was produced and in the eight following days the average daily elimination of sugar was fifty one-hundredths of one per cent. After correction of lesion, this animal showed an average of two-tenths of one per cent of sugar for two consecutive days, and for the following six days the urine was absolutely free from sugar. During period of lesion this animal lost constantly in weight.

Monkey No. 8. During time of normalization, seventeen analyses were made. For seven days of this time the daily average was twenty-four hundredths of one per cent of sugar. (It was during these days that the banana diet was used.) During the remainder of the normalization period the urine was free from sugar, giving a daily average of one-tenth of one per cent for the entire time. After the production of a mid-dorsal lesion, the urine showed a daily average of four-tenths per cent of sugar for the ten following days.

After reduction of the lesion, analyses were made for the five following days. These showed slight traces of sugar for the first two days and sugar-free urine for the remaining time.

Monkey No. 9. During the normalization period, nine analyses were made. The daily sugar average was eight hundredths of one per cent. This animal was kept in lesion one week and during that time showed a daily average sugar elimination of thirty one-hundredths of one per cent. After reduction of the lesion, sugar-free urine was voided.

Monkey No. 11. This animal was normalized for a period of four weeks. Seven analyses were made during this time and only once was sugar found. This gave a total average of five hundredths of one per cent. For the following ten days after animal showed sugar every day except two, giving a daily average of thirty-six one-hundredths of one per cent. Correction of lesion in this animal was not effected.

Monkey No. 12. Normalization record was kept on this animal for one month, during which time eight analyses were made. These showed a daily average of fourteen one-

hundredths of one per cent sugar. A mid-dorsal lesion was produced. The urine on the following day showed sugar and continued to do so for eight days. The average amount during this period was forty-eight-hundredths of one per cent daily. Eleven analyses were made after correction, which showed a daily average of six-hundredths of one per cent.

Tests for acetone and di-acetic acid were made on the animals during the time they were showing sugar, but at no time were such substances found present.

The presence of sugar in the urine during the period of normalization was in all probability due to an excess of bananas being given in the diet, as the sugar appeared in all the animals' urine at the same time and at a time when bananas were being heavily fed. After taking the bananas from the diet and using grain and acid fruits instead, the sugar elimination ceased. This same diet of grain, apples, etc., was used during the times of lesion and following correction and was kept constant, no variations being made in it.

Summary.

All animals used showed a much increased amount of sugar elimination during time of lesion, which was either greatly reduced or entirely eliminated when the bony subluxation was corrected. We believe the sugar elimination to have been pathological as the animals constantly lost weight during the same time. Other abnormal changes appeared in the urine during these times, but as a continuous record of these was not obtainable owing to the small amount of urine voided daily being used for the sugar tests, no report is made concerning these disturbances.

The presence of such amounts of sugar as appeared during the time the animals were in lesion definitely shows this: That in some manner bony subluxation produced in the mid-dorsal region of the spine deranged body metabolism, and caused functional disturbances of the nutritional processes.

Other Functional Disturbances Following Lesion.

Monkey No. 7. This animal was kept under observation for fifty-eight days before lesioning. During this period

the animal was in perfect health and increased some in weight. After lesion in the upper and mid-thoracic region, the animal lost in weight from 1,020 to 900 grams in two weeks. It then contracted pneumonia and died in three days after the first symptoms appeared. On post-mortem the lungs were found badly congested.

Monkey No. 11. This was a female Rhesus monkey seemingly in good health, except that it coughed occasionally. Bacteriological examination of throat smears failed to show any specific infection. After lesion in upper dorsal, there was an extreme diarrhoea, and the cough grew worse. The diarrhoea stopped after corrective treatment applied to the lower thoracic region, but the cough and other symptoms increased. The animal was now losing weight very fast. It seemed to be hungry and ate well, but gradually grew weaker and became very inactive. Extreme swelling of the face region and much cyanosis had developed one week later, when it died.

Post mortem examination showed a general systemic acute miliary tuberculosis. Practically every visceral structure was involved. In this case we are quite sure that the animal had tuberculosis when it was received, but certainly in these two animals there is much reason to believe that the lesions acted as in the one case (No. 7) predisposing, and in the second case (No. 11) an exciting factor to the infective processes.

Monkey No. 6. This was an old Ring-tail, but was in good physical condition when received and remained so for two weeks, the appetite was good and the urine and feces were normal. At this time it received a severe fall. Its keeper accidentally threw it hard against the floor when it tried to bite him. The animal gave evidence of an injured neck; after four days it was not so lively and seemed ill; ten days later there was trouble with its right arm; it would put the left arm only out for food and did not use both hands ambidexterously as formerly, and as all monkeys do while eating. A few days later the right leg was involved. This gradually progressed until the right arm was completely spastic. The left limbs were also involved and the left arm showed signs comparable to intentional tremor when it reached for food. It was very irritable during the entire time. After death, on post mortem examination, the atlas and axis were both found to be slightly anterior and rotated to the right. There were no other bony lesions, nor was there any evidence of trauma to the cord. We think the symptoms could not be explained by the theory of "spinal shock." Probably the term "spinal

strain" of an extreme type, some of the effects of which have been given in a previous series, would explain the causes in this case.

Report on Pathology.

T. L. McBeath, D. O.

The animals were killed by administering ether, and were posted by Dr. Deason and myself. The skin was carefully dissected from the median line and laid back. The abdomen was opened and the viscera examined before removed. The blood vessels were ligated and the viscera removed entire and placed in sterile beakers containing normal salt solution, where they were washed two hours; then in Zenker's fluid thirty-six hours; running water twenty-four hours, after which dissection was made and tissues cut into small pieces, two by four centimeters thick and placed in 50 per cent alcohol, tinged with iodin to color of sherry wine to dissolve out the mercury.

Hardening Process.—Tissues were passed through different grades of alcohol, 70, 80, 90 and 95 per cent, absolute, 24 hours each. Dehydration; ether and absolute alcohol, half and half, 24 hours.

Embedding; thin celloidin 5 per cent, 36 hours; thick celloidin 12 per cent, 36 hours; and then placed in dishes filled with thick celloidin and allowed to harden 24 hours.

They were then removed and trimmed into small pieces and mounted on wooden blocks, allowed to stand one hour and placed in 80 per cent alcohol to harden.

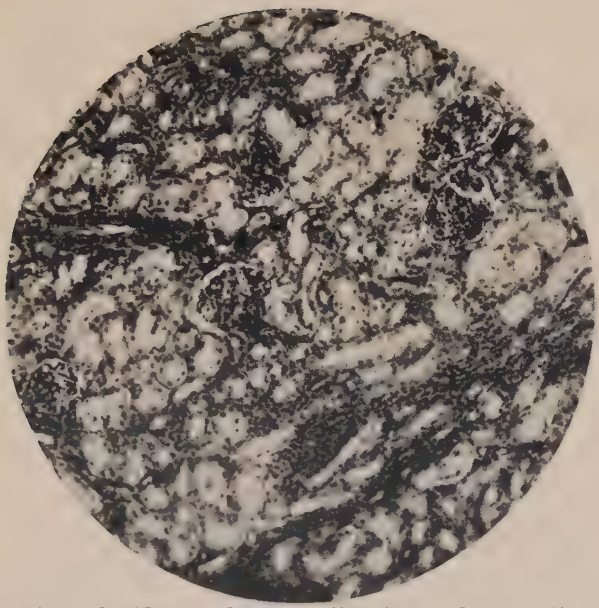
Sectioning.—Specimens cut 10 microns thick under 80 per cent alcohol and placed in 80 per cent alcohol, then transferred to distilled water.

Staining.—Hematoxylin. 5 minutes; wash in distilled water three washings. Destain 1 per cent acid alcohol and transferred to water. Eosin, 2 per cent, 1 minute, wash in 95 per cent alcohol three washings. Clear in creosote solution, (creosote, 50 c. c.; cedar wood oil, 50 c. c.; oil of Bergamot, 25 cc.) Blot thoroughly and mount in Canada balsam. Bake in oven, heated to 70 degrees Centigrade, 2 hours.

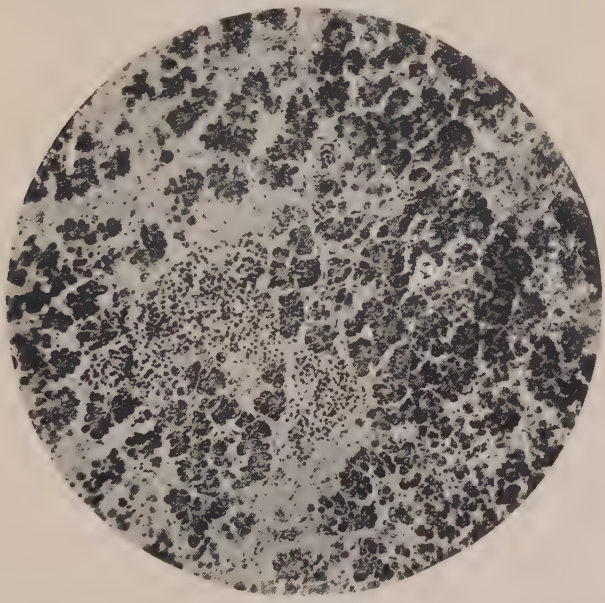
Results.

Pancreas:—Shows infiltration of fibrous tissue running in between the glandular structure. The Islands of Longerhans show fibrosis (fibrous tissue surrounding and infiltrating into the glandular structure of the islands.)

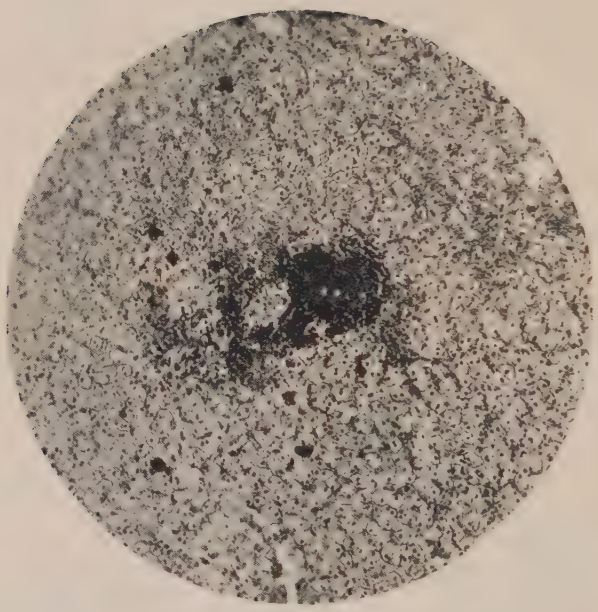
Kidneys:—Show slight albuminous degeneration in the first convoluted tubules in cortical area, the renal epithe-



Section of kidneys showing albuminous degeneration. Taken from monkey lesioned in lower thoracic region.
X120 diameters. (Reduced 20%)



Section of pancreas from monkey lesioned in mid and lower thoracic regions. Islands of Langerhans show fibrosis.
X120 diameters. (Reduced 20%)



Section of liver taken from monkey lesioned in mid thoracic showing small abscesses and albuminous degeneration.
X120 diameters. (Reduced 20%)

lium is frayed into the lumen and the cytoplasm appears granular.

Liver:—Outline of cell membrane intact, the cytoplasm slightly granular in intermediate portion of lobules; also small abscess near hepatic artery, showing accumulation polymorpho-nuclear leucocytes in surrounding tissue, causing slight necrosis of tissue.

CONTROL WORK ON MAMMILIAN

Series No. 15.

(Series Nos. 2 and 7.)

H. L. Collins and Chas. R. Eitel.

Since the results of Series No. 7 done by us last year dove-tail so nicely with work done by Doctors Deason and Robb in Series No. 2, the results of one series strongly supporting the other, it seemed advisable to continue work on these series. As our work along this line was simply to act as a control on Mammalian Series Nos. 2 and 7, it would not be necessary for any lengthy or detailed account here, but just a few statements of our findings, which will be self-explanatory.

Seven dogs were used in this series. The methods and precautions taken in this series are the same as those in Series No. 7.

In almost every instance pressure, flexion, or manipulation in the lower cervical and upper dorsal regions, with a fixed point, gave an increase in blood pressure. The fact was also confirmed that when flexion was applied to the vertebrae with no fixed point, there was not nearly as much variation produced as when a fixed point was established. In the few exceptions to these results, there was a vertebral lesion found in some of the dogs which might have produced these contrary findings, but as there were so few of these negative results obtained and so many in the affirmative, we are forced to believe that manipulation, pressure or flexion in the lower cervical and upper dorsal produces an increase in blood pressure, and the same movement, viz., pressure, manipulation or flexion in the lower dorsal and lumbar, produces a decrease in blood pressure.

One interesting thing might be restated from the work done by Doctors Deason and Robb: When two different kinds of stimulation were used in one region they confirmed our results of Series No. 7. We will mention one

instance here. When rotation and pressure were both applied to the upper lumbar, a decrease in blood pressure in both instances was recorded. This not only helps to prove the statement of Series No. 2, but also upholds our findings, which are stated in Series No. 7.

CONCLUSIONS:

In summing up the problem we find:

1. Vertebral movements, when applied to different areas of the spine, produce radically different effects, as has been stated in Series No. 2;

2. That flexion of the spine, with a local fixation, gives more marked results than flexion without fixation;

3. That the effects of muscular massage are inconsiderable as compared with spinal movement with fixation;

4. The results of Series Nos. 16 and 17 confirm our findings and the results of Series No. 2, that manipulation of different areas of the spine produces not only different, but more or less, specific physiological results. These findings are confirmatory of Series No. 2.

EFFECTS OF SPONDYLOTHERAPIC AND OSTEOPATHIC STIMULATION ON THE SECRETION OF URINE

Series No. 16.

C. A. Pengra and G. A. Alexander

It is the purpose of this series of experiments to determine as far as possible the effects upon the secretion of urine by the kidneys when stimulated by the application of spondylotherapic concussion and of osteopathic manipulation in the region of the spine, from which the nerve supply of the kidney is derived.

It is not the purpose to determine the correctness of, nor to corroborate nor disprove, any theory that has been advanced regarding the secretion by the kidneys whether it be the original theory of Ludwig that "urine is formed by the simple physical process of filtration and diffusion," or the later theory of Bowman and Heidenhain, which assumes that "water and inorganic salts are produced in the glomeruli, while urea and related bodies are eliminated through the activity of the epithelial cells in the convoluted tubules". (Howell).

The animals used were dogs, eleven in number, to ten of which ether was administered, deeply, and constantly by means of the tracheal cannula.

The animals were not operated after anesthetization until such time as respiration became rhythmical and pulsation strong and regular, when an abdominal incision was made in the median line, and both ureters were cannulated, the cannulas being long and extending out into graduated test tubes. Again, time was allowed for the rate of flow to become normal, i. e., to regulate itself after any possible shock of the operation to even and regular flow.

Several counts were then taken, about ten minutes apart, to ascertain the exact rate of normal flow, after which stimulation was applied by concussion and manipulation to the regions indicated, sufficient time being allowed

each time for the effects to be demonstrated and for normalization to occur. It will be observed that the increase in flow after osteopathic manipulation was applied invariably remained constant until the animal was killed, which was not brought about for a period in many cases of from one to two hours.

The very noticeable variations in normal flow between the different animals experimented upon was due principally to variations in size, strength and age, as of course uniformity in the qualities is impossible, although the strongest dogs obtainable were used in each instance and none but normal animals were used.

In the application of stimulation by means of spondylotherapic concussion, as suggested by Dr. Albert Abrams in his book (second edition) on treatment, by this method the concussion was applied by the use of a light hammer and a rubber cork, as a percussion pad, always lightly at first and gradually increased to heavy; but, as will be noted in the experiments listed, our best efforts failed to produce the desired results by this method and, in fact, not the slightest change in rate of flow was noted.

The osteopathic manipulation was applied altogether by lateral rotation, making fixed points of the spines of two adjacent vertebrae. In order to know that the effects were being produced directly by stimulation of some nerve mechanism to the organ and not by increase in general blood pressure, or by any change in rate or amplitude of heart beat, or of respiration, the mercury manometer was attached to the carotid and the pneumograph to the trachea of the animal, but these instruments failed to record any variations which would be indicative of the changes sought in respiration or in general blood pressure.

Following is a list of five of the dogs operated, the remaining six not being listed for lack of space, showed similar results:

Dog No. 1. Operated 2:45 p. m.; normalized 3:20 p. m.

Four counts taken to ascertain the normal rate of flow showed the left ureter to be eleven drops per five minutes and the right to be ten drops per five minutes.

At 3:45 p. m. concussion was applied; as stated above, without effect.

At 4:00 p. m. osteopathic manipulations were applied resulting in an increase of two drops per each ureter per five minutes or an increase of 20 per cent.

A second count taken at 4:25 p. m. showed a second increase of one drop per ureter per five minutes.

At 4:40 p. m. the same manipulation applied to the same region resulted in increasing the flow of the right ureter to sixteen drops and the left to eighteen drops per five minutes, or more than 20 per cent.

At 5:00 p. m. the flow remained the same, and the dog was killed.

Dog No. 2. Operated 2:00 p. m.; normalized 2:30 p. m.

Four counts were taken to ascertain normal flow of eight drops for each ureter per five minutes.

At 3:15 p. m. concussion was applied, as above stated, without effect.

At 3:50 p. m. a count showed a normal flow of eight drops per five minutes.

At 4:00 p. m. osteopathic manipulations were applied with an increase to nine drops per each ureter per five minutes, or an increase of 12½ per cent.

At 4:40 p. m. the count remained the same, and the dog was killed.

Dog No. 3. Operated 2:30 p. m.; normalized 2:50 p. m.

Three counts were taken to ascertain normal flow of eight drops per ureter per each five minutes.

At 3:05 p. m. concussion was applied as usual, without effect.

At 3:40 p. m. osteopathic stimulation applied showed an increase to nine drops per ureter for each five minutes, or an increase of 12½ per cent.

At 4:20 p. m. a count was taken, showing a flow of ten drops per ureter for five minutes, or an increase of more than 10 per cent.

This rate remained constant until 5:05 p. m., when the dog was killed, the total increase being 25 per cent.

Dog No. 4. Operated 2:45 p. m.; normalized 3:20 p. m.

Four counts were taken to ascertain the normal flow, which was six drops per ureter per five minutes.

Concussion was applied and at 4:00 p. m. the count remained normal at six drops.

At 4:10 p. m. osteopathic manipulation, with resultant increase to nine drops per ureter for five minutes.

At 4:30 p. m. a count showed the flow to have increased to ten drops, or an increase of 66 2-3 per cent.

At 4:40 p. m. the same stimulation was applied again, resulting in an increase to thirteen drops per ureter, or a total increase of 116 2-3 per cent, which remained constant until the dog was killed at 5:25 p. m.

In all of the above experiments, both concussion and osteopathic manipulation were applied to all segments of the spine from the 8th dorsal to the 2nd lumbar inclusive, but no results were obtained except by osteopathic manipulation in the region of the 12th and 13th dorsal, which corresponds to the 11th and 12th dorsal in the human, the dog having thirteen dorsal vertebrae.

Dog No. 11. This animal was operated under aseptic conditions, ether being administered by means of a cone, after which it was thoroughly bandaged, the cannulas passing to the outside through a slit in the gauze.

It was then swung in an improvised hammock in a sterile cage, in such a manner that it could cause no injury to itself.

Two hours after the dog had recovered from the effects of the anesthetic, counts were taken to ascertain the normal flow of urine, which was eleven drops ureter for fifteen minutes.

Osteopathic manipulation applied to the region of the 12th and 13th dorsal increased the flow immediately to 18 drops per ureter per fifteen minutes.

Another count, thirty minutes later, showed that the flow had again increased to 26 drops per ureter per fifteen minutes, a total increase of 136 per cent.

The animal was then taken from the hammock and allowed to rest in the cage over night.

At 9:00 a. m. the following day the animal's temperature was 37°C. (normal), but it seemed very thirsty; was given milk.

A count was taken to ascertain the normal flow, which showed it to have remained almost constant during the night, being twenty-four drops per ureter per fifteen minutes.

Because the animal seemed thirsty and the count still remained high, it would seem that the total amount of elimination had been much increased during the period.

The same manipulations were applied as on the previous day, resulting in an increase to 36 drops per ureter

per fifteen minutes. A second count was taken one hour later, showing that this increase had remained constant.

This animal was examined thoroughly at 3:00 p. m. the same day and found to be in perfect condition, the temperature being normal and no signs of infection from the operation.

Summary and Conclusion.

J. Deason, M. S., D. O.

The above series of experiments was done under my direct supervision and I believe every possible precaution was observed to eliminate errors.

The care and operative technic of these workers was excellent. No animal suffered from shock due to unnecessary exposure, the greatest care was exercised in the handling of the animals to avoid undue mechanical stimulation, etc., and the results obtained could not possibly have been due to anything other than spinal manipulation. Further evidence of this was shown in Dog No. 11, which showed even greater increase in urine secretion from spinal treatment than the animals while under the influence of ether. The increase, therefore, cannot be attributed to the effects of the anesthetic or any careless handling while being operated.

It may be suggested that the results came from massage of the spinal musculature, but that this is not at all probable, we cite the reader to Series Nos. 2 and 15 of our mammalian experiments, which show that massage is neither so effective nor specific as osteopathic treatment. Those who wish to explain these effects by massage will first have to answer this question, viz., why is this excessive activity caused only by a specified kind of spinal treatment applied to a specified area, while other methods utterly fail?

From the results of this work we may draw the following conclusions:

First—That spinal concussion, when thoroughly tested, produces absolutely no effect upon the functional activity of the kidneys;

Second—That by proper osteopathic manipulations the functional activity (secretion) of the kidneys can be increased from 20 per cent. to 100 per cent., or even more;

Third—That this increased activity lasts for a sufficient length of time to very materially reduce the body water content;

Fourth—That there is a certain definite region of the spine (11th and 12th dorsal) from which the autonomics originate, which control the functions of the kidneys;

Fifth—Since there are no changes in systemic blood pressure this increased function of the kidneys is due either to specific vaso-motor or secretory (trophic) nerve fibres, which may be influenced without causing general systemic vaso-motor changes;

Sixth—That spinal treatment may be given in such a way as to be specific in effect, i. e., to affect only certain functions.

Osteopathic Significance

It has been shown, (Series 4 and 12), that bony lesions of the lower thoracic and upper lumbar regions produced artificially in normal animals affect the normal functions of the kidneys. Clinically, many cases of kidney trouble have been demonstrated to be due to similar lesions.

In this series it has been shown conclusively that the secretion of the kidneys can be increased from 12 per cent. to 100 per cent. by stimulatory treatment applied to the eleventh and twelfth thoracic segments of the spine. The secretion thus produced often remains increased for two or three hours or longer during which time the water content of the body is greatly reduced.

This same experiment has been tried with equal success on the human, and by this means in cases of febrile conditions the toxins of the body fluids and the temperature have been much reduced in a number of cases in which the test has been applied.

The practical significance of such treatment is therefore apparent. If the toxin content of the blood can be materially reduced, as this experimental evidence shows it can be, this is a very efficient method of treatment in infectious fevers.

Spinal manipulation, which produces free movement between the vertebrae named, should be continued for ten

or fifteen minutes at each treatment and several such treatments given daily during the febrile state.

Dr. McConnell has shown that bony lesions of the mid-dorsal and lower regions are followed by pathological lesions of the kidney, and Dr. Burns has shown that lesions of the 11th and 12th thoracic produce vaso-dilation of the vessels of the kidneys.

OSTEOPATHIC STIMULATION OF BILE-FLOW

Series No. 17.

Geo. D. Scott and H. A. Wendorff.

This is the record of a series of experiments undertaken at the instance of Dr. J. Deason in the laboratories of the American School of Osteopathy to ascertain whether or not the osteopathic physician can in any way influence the flow of bile. As will be seen, the results were most gratifying. Carefully tabulated records were kept of the findings, but as the whole series of tables would occupy an undue amount of space, it is deemed best to give only the results obtained in each case and to group them all in one table.

Methods and Technique.

Dogs were the only animals used; the technique was extremely difficult and tedious, but great care was taken to assure that the results obtained were exactly accurate in each case.

All dogs were put under complete anesthesia by means of ether given by tracheal cannulae. The animal was tied onto a table of small size kept for the purpose, and an incision made in the abdomen, extending from the xiphoid toward the symphysis. The operator then passed his hand into the abdominal cavity, grasped the common bile duct and pancreatic duct and other structures thereto attached, and after closing off the bile duct by means of a "bulldog," it was cannulated at a point above its junction with the pancreatic duct.

Many peculiarities of structure were found in different animals, and the operators were obliged to lose many dogs without even getting the duct cannulated. One animal

had a bilateral liver, and the common bile duct was divided up into so many smaller ducts that nothing could be done. This is only one illustration of the difficulties met with. In fact, a lengthy article could be written on the abnormalities of structure found in many of the animals opened.

After cannulating the duct and inspecting the gall-bladder to see that it was normal and to ascertain the approximate content, the "bulldog" was removed, the edges of the skin brought together and fastened, the right limbs untied from the table, and the animal turned onto the left side.

Stimulation was effected by rotation of the seventh to ninth dorsal vertebrae, but mostly the eighth, as follows: The operator stood at the animal's back and, in order that there might be no compression on the abdominal cavity, thus influencing the flow of bile, grasped the dog's right foreleg in the right hand and with the right rotated the vertebrae by means of the spinous processes. At the close of each experiment the gall-bladder was again examined and in every case found to contain as much bile as at the beginning, with one or two exceptions, when a perceptible increase was present.

	Normal flow in 15 min. drops.	Flow in 15 min. stim. mid-dorsal.		Flow after stim. ended drops 15 min.
Dog No. 1.	55	72	30.9% inc.	68
Dog No. 2.	41	78	90.2% inc.	74
Dog No. 3.	46	69	50 % inc.	65
Dog No. 4.	57	76	31.5% inc.	67
Dog No. 5.	52	74	42.3% inc.	69
Dog No. 6.	45	81	80 % inc.	75
Average	49	75	53 % inc.	69.6

As will be seen from the above table, the normal rate of flow was taken before stimulation was started and again after stimulation ceased, and the increase in flow from the manipulation continued for some time afterward, though not at the same rate. In one or two cases by count,

the increase was noted for as long as half an hour, it gradually receding toward the normal.

Some animals, other than those from which results are tabulated above, were prepared in the usual way and "spondylotherapy" attempted by percussing the spines of the vertebrae in the same region as stated above, but in not a single instance was there an increase in the bile-flow, and the experiments were abandoned in disgust. Five dogs were used in this way. The carotid artery and trachea were attached to the kimograph, but not the least variation in either blood pressure or respiration occurred during the percussion.

As it bears directly on this series of experiments, it may not be out of place to quote here a few extracts from Dr. J. Deason's "Osteopathic Physiology."

It is not surprising that the many attempts made by workers in general physiology have so far failed to demonstrate the functions of the nerve supply to the liver as well as the influence of the nerves to many other secreting glands. The methods in common use by most mammalian experimenters are enough in themselves to defeat their purposes. The stimulation, for example, of nerve trunks by artificial methods is a very unsatisfactory procedure and can surely not always be relied upon as giving satisfactory results. As has been explained above, the stimulation of the peripheral end of the vagus does not always produce secretion in the stomach glands, and when it does the stimulation is followed first by a period of latency, during which time there is no secretion.

It is definitely known that the vagus is secretory to the stomach and that the taking of food in the mouth is quickly followed by secretion. Why, then, does the direct stimulation not cause secretion? It is probably caused by the inefficient methods used, overstimulation, or something of that nature. The same explanation probably holds good for the liver, pancreas, and other secretory glands, and the

fact that secretory nerves to the liver have not been demonstrated is of no great significance.***

According to the theory of secretion of the liver being due to an increased blood supply and that only, stimulation of this region should cause a decrease of secretion according to the theory stated in general physiology, as the splanchnic fibers are supposed to be vasoconstrictors and would thus decrease the blood supply to that gland. The work on this series has been done so carefully that there seems to be no possible doubt of the result, and we must therefore attribute the excessive secretion following such stimulation to specific secretory nerves or to vasodilator effects. It seems most reasonable to accept the theory of secretory or trophic nerves.

THE EFFECT OF SPINAL MANIPULATION UPON THE SECRETION OF BILE

Series No. 18.

By H. A. Wendorff, D. O.

Report of the A. T. Still Research Institute.

Some work was done on this subject at the A. S. O. by Dr. George D. Scott and the present writer under the direction of Dr. Deason with results as given in Series No. 17. It was thought well to continue the work in order to be able to state more positively whether or not manipulation affected the flow of bile. As described below technique has been materially changed so that now the operation is done with no strain being put upon the bile duct in cannulating it and also by tieing the cystic duct we know that all the bile comes directly from the liver and not from the gall bladder.

Animals and Technique.

In the work this year we have records of twenty-seven dogs used. Dogs were used because they are very easily obtained and also because they are large enough to be easily handled. Ether was given by the usual method in animal experiments, a tracheal cannula was inserted into the trachea and connected with an ether bottle in such a manner that the amount of air to the animal could be easily regulated. By this method an animal may be kept at a constant state of anesthesia for as long a period as necessary with very little attention. After the tracheal cannula was inserted the abdominal cavity was opened by an incision extending from a point just below the xyphoid process downward for about three inches, and another

incision extending from the same point lateral to the right for about the same distance missing the ribs about half an inch. The three cornered flap thus made was next turned back and the bile duct picked up. With this sort of an incision the work can be carried on with very little traction being put upon the duct and with little disturbance to it. Having located the duct a ligature was placed around the cystic duct by simply raising the lobes of the liver in order that it may be seen and then passing a ligature back of it by means of an aneurism needle. Having made sure the cystic duct was tied the common bile duct was picked up at a point about one-half inch above its entrance into the duodenum and a glass cannula inserted with as little disturbance to the duct as possible. In almost every case the bile would begin to flow into the cannula at once. A small rubber tube was then attached to the other end of the cannula and brought to the outside. The incision was closed as soon as possible to avoid shock.

To record the flow and obtain a permanent record a kymographic record was made by having a signal magnet connected with a battery and a spring key, the indicator of the magnet resting upon the smoked kymograph paper. The kymograph was then started and at each drop the key pressed when the indicator would record the drop. With the kymograph wound to the same extent, 10 second periods were marked off on the smoked surface below the record in order to be able to time the drops.

After normal flow was recorded, the stimulation was carried on in the following two ways.

1st. The dog was turned on the side, the shoulder grasped in one hand while fixation of the 9th thoracic vertebra was accomplished with the other. In this manner movement of the 8th and 9th vertebræ was obtained.

2nd. Dog on back, firm steady pressure upward at the 8th and 9th with a finger of each hand at the articulation, one being placed on each side.

The following is a table of the results obtained. It will be noticed that in eight animals the cystic duct was not tied. This was done for a comparison of results.

Dog No.	Duct.	Normal flow in 10 minutes.	Flow after Stim. 10 minutes.	% change
1.	tied	23 drops in 20 m.	28 drops in 11 m.	120.9 inc.
2.	tied	11 drops	11 drops	no inc.
3.	tied	15 drops	26 drops	77.3 inc.
4.	tied	22 drops in 20 m.	9 drops in 5 m.	63 inc.
5.	tied	24 drops in 20 m.	19 drops in 10 m.	58.8 inc.
6.	tied	15 drops	12 drops in 5 m.	60 inc.
7.	tied	60 drops in 20 m.	17 drops in 5 m.	3 inc.
8.	tied	39 drops in 20 m.	40 drops in 10 m.	120 inc.
9.	tied	15 drops in 20 m.	5 drops in 10 m.	decrease
10.	tied	28 drops in 20 m.	7 drops in 5 m.	no change
11.	not tied	43 drops in 10 m.	36 drops in 10 m.	decrease
12.	tied	18 drops in 10 m.	10 drops in 10 m.	decrease
13.	tied	5 drops in 10 m.	10 drops in 10 m.	decrease
14.	tied			no inc.
15.	not tied	14 drops	31 drops in 15 m.	47 inc.
16.	tied	20 drops	23 drops in 30 m.	decrease
17	not tied	13 drops	30 drops in 10 m.	130 inc.
18.	not tied	13 drops	19 drops in 10 m.	46 inc.
19.	not tied	28 drops	15 drops in 20 m.	decrease
20.	not tied	1 drop in 10 m.	68 drops in 10 m.	great inc.
21.	not tied	30 drops	40 drops	33 inc.
22.	tied			33 inc.
23		Died under ether.		
24.	tied	no flow	32 drops in 20 m.	m'rk'd in.
25.	tied	28 drops	35 drops	14. inc.
26.	tied	15 drops	35 drops in 20 m.	16.6 inc.
27.	tied	8 drops	16 drops in 20 m.	no inc.

Of the nineteen cases in which the duct was tied, twelve showed an increased flow. In the seven cases where the duct was not tied the flow was increased in five and decreased in two. While it is not possible to state that the bile in the eight cases came directly from the liver, to all appearances the gall bladder was just as full at the end of the experiment as at the beginning, therefore, we can feel safe in presuming that part of it did come from the liver directly. In the cases where the cystic duct was tied all the bile came directly from the liver, therefore the increase was due to an increased output. Whether this was due to secretory action being stimulated or whether it was due to

an increased amount of it we are not able to say. In every case the bile was of a more stringy consistency and in several cases where it was weighed the bile after stimulation was heavier than that collected before.

Conclusion.

From the above results we would say that manipulation at the eighth and ninth thoracic vertebræ does produce an increased flow of bile; that the percentage of components of the bile are different because of the fact that the consistency was changed and the specific gravity in several cases was increased.

SOME EFFECTS OF SPINAL CONCUSSION

J. H. SPITLER, L. L. B.

SERIES NO. 19.

STATEMENT OF PROBLEM.

This series was suggested by Dr. J. Deason and the work was done under his direction for the purpose of establishing the truth or falsity of the statement of Dr. Albert Abrams in his latest revised work on Spondylotherapy relative to the effects of his methods of concussion thereby eliciting certain visceral reflexes, more particularly that of the stomach, but the observations covered the intestines as well, special interest being centered upon the so-called stomach reflexes.

The series was carefully done, the technique being followed absolutely as directed by Dr. Abrams and our findings hereinafter set out will speak for themselves.

LITERATURE.

On page 325 of the third edition, he says, "To contract the stomach and to augment the tone of its muscles two methods are available; (1) By aid of the sinusoidal current; (2) By concussion of the spines of the first three lumbar vertebræ." In the discussion of the author on the subject of intestinal reflexes he maintains that different areas of the spine may be stimulated to cause a specific kind of reflex. For example, Dr. Abrams claims to be able to treat different kinds of conditions causative of constipation by the use of this method. When a condition of spastic constipation exists he would treat the condition by "concussion of the spines of the first three lumbar vertebræ" and "When neither form of constipation predominates. sinusoidalization or concussion at the same seance may alternate between the spine of the 11th dorsal vertebræ, to stimulate the longitudinal muscular fibers, and the spines of the first three lumbar vertebræ to excite contraction of the circular fibers of the intestines." We believe

it would be more scientific to establish this as a fact before proceeding with such an absolute statement.

As another example this author in a further consideration of intestinal reflexes states as follows: "Firm and deep pressure alongside of the first three lumbar vertebræ will also evoke this reflex; pressure on the right side of the spines in question will contract the intestines only on the right side, whereas pressure on the left side will only influence the intestines on that side."

Concerning the reflexes of the pylorus this author states, page 587 and 588, that "concussion of the 5th dorsal spine or paravertebral pressure, (page 467), will *enlarge the pylorus* (dilatation) and that similar maneuvers limited to the 3rd dorsal spine will *contract the pylorus.* In other words, we elicit the pyloric reflexes of dilation and contraction." He also states that "the dilator nerve of the cardia is a closing nerve for the pylorus." This statement seems scarcely probable because it is known that the contractions of the stomach (the contraction waves) pass on over the pylorus and through the intestines only at certain intervals and that the opening of the pylorus is dependent upon the condition and acidity of the contents of the antrum. The author also claims to be able to affect the peristaltic waves of the stomach by concussion of certain dorsal vertebræ. We will offer experimental evidence to show that this cannot be demonstrated in living animals.

In would be unjust to give the results of these findings here, without making reference to some of our recognized physiologists their work and theories, and we may draw logical conclusions from the results obtained and observe that the findings which were made are not altogether new, but are a reestablishment of the claims made by osteopathic research workers several years ago, and especially those set out in series No. 7 and No. 12.

Technique.

Ten animals were used in this series consisting of dogs and cats, the dogs being anesthetized by means of a tracheal cannula and upon the cats a mask was used. After uniform anesthesia by means of ether and being placed upon a specially prepared table covered with canvas so as to

expose the vertebræ for concussion, a window was made in the abdominal wall by incision through the linea alba; the edges of the abdominal wall were then held by hemostats on either side, and they in turn were attached to a ring stand thus forming a pocket into which was placed normal (physiological) salt solution at body temperature sufficient to fill the cavity in order to prevent shock from exposure to the atmosphere, and through this window observations were made at stated intervals during concussion and at stated times thereafter. Concussion was effected by placing the finger upon the spinous processes of the various vertebræ suggested and delivering a series of vigorous rapid blows with a hammer of small size, afterwards allowing the animal a period of rest, and for observation. From ten to twenty minutes were allowed for observation after percussion before the process was again resorted to, and the notations were made as shown in our results at the time of observation. Only normal animals were used and those which showed an abnormality were discarded.

RESULTS.

Animal	Time	Percussion	Results
Cat No. 1.	3 min.	9th dorsal	No visceral change.
	3 min.	7th dorsal	No visceral change.
	3 min.	5th dorsal	No visceral change.
Cat No. 2.			Strong peristalsis at beginning.
	3 min.	9th dorsal	Peristalsis strong no change.
	3 min.	7th dorsal	Less movement still strong.
	3 min.	5th dorsal	Condition unchanged.
Cat No. 3.	No peristalsis movement at beginning. Stomach tympanitic and would not respond to stimulus. Percussion of 5th, 7th and 9th dorsal gave no results.		
Cat No. 4.			Normal peristalsis.
	3 min.	5th dorsal	No change.
	3 min.	7th dorsal	Slight increase.
	3 min.	9th dorsal	Peristalsis ceased and could not be stimulated again.
Dog No. 1.	3 min.	9th dorsal	Slight peristalsis.
	3 min.	7th dorsal	Slight increase.
	3 min.	5th dorsal	No change.
	3 min.	9th dorsal	No change.

Dog No. 2.	3 min.	7th dorsal	Slight peristalsis.
	3 min.	5th dorsal	No change.
	3 min.	7th dorsal	No change.
	3 min.	5th dorsal	Slight increase.
Dog No. 3.	3 min.	5th dorsal	Strong peristalsis.
	3 min.	7th dorsal	Slight decrease.
	3 min.	9th dorsal	No change.
Dog No. 4.	3 min.	7th dorsal	Medium peristalsis.
	3 min.	9th dorsal	Slight increase.
	3 min.	5th dorsal	Slight increase.
Dog No. 5.	3 min.	5th dorsal	Slight peristalsis.
	3 min.	7th dorsal	No change.
	3 min.	9th dorsal	No change.
Dog No. 6.	3 min.	5th dorsal	Strong peristalsis.
	3 min.	7th dorsal	No change.
	3 min.	9th dorsal	No change.

In the experiments above referred to, series No. 7 and No. 12 the effect of osteopathic stimulation was clearly set out and therefore only mention of it is necessary here, but we might say that in order to check up the results of these former experiments, osteopathic manipulation was given after the findings were made in this experiment on several animals, with the results as therein shown being verified.

In the above report there are some slight changes noted in the viscero-motion, but the changes were not purely physiological variations and no changes could be noted as a result of the percussion. In cat No. 3, the stomach was very much distended with gas and a great deal of time was spent on the 5th dorsal, both by percussion and paravertebral pressure in trying to effect a relaxation of the pylorus with no results. Neither could we elicit a reflex on one side nor on any part of the intestines as stated by Dr. Abrams. There was no noticeable effect from paravertebral pressure with the thumbs.

Conclusions.

By J. Deason.

From the results of the above and other work which we have done along this line we think it is safe to conclude that Dr. Abrams has made statements which not only disagree with present knowledge of anatomy and physiology, but which cannot be demonstrated experimentally.

INTEROSSEOUS LESIONS AND THEIR RELATION TO NUTRITION

By Dr. J. Deason.

Series No. 20.

For the purpose of collecting some definite information on the subject of nutrition, the following experimental work has been done:

In our Series No. 4, a careful study was made of thirty-three dogs, but many of these animals were found to be abnormal and were therefore unfit for use. The following results show the effects of produced lesions on nutrition in normal animals. These were all full grown dogs and in perfect condition at the time of lesioning.[1]

Dog No. 2. This dog was kept under observation for seven weeks before lesioning. The weight at the time of lesioning was 11,300 gms. Twenty-six days after the lesion had been produced (in the lower dorsal region) the animal had gained to 12,000 gms. The animal was kept under observation for nearly seven months after lesioning during which time it showed a constant low glycosuria varying from one-fourth to one per cent of sugar daily, but no loss in weight or other nutritional disturbances were observed.

Dog No. 4. This dog was about eight years old and weighed 1,003 gms. The general condition and nutrition was fair, but the animal showed only a slight increase in weight during one month of normalization. This might have been due to the age. It showed only a trace of sugar on three different days during this period. After lesioning in the tenth and eleventh dorsals (rotation) the animal was observed for twelve days. The weight decreased to 8,040 gms. and the animal became very weak.

1 During the period of normalization all animals were kept for from two weeks to three months and under as nearly ideal conditions as possible including proper dieting, moderate exercise, cleanliness, etc. Nearly all animals increase in weight under these conditions. This factor may account in part for the continued increase in weight after lesioning. During this period the animals were weighed regularly and samples of urine were collected and analyzed daily. Any animal which was found to be abnormal was discarded.

Dog No. 7. This dog increased in weight from 16,000 to 17,225 gms. during a month of normalization and was in perfect condition in every way. After lesioning (rotation between ninth and tenth dorsal) it showed varying amount of glycosuria, an average of two-tenths per cent. During the first two months after lesion the dog continued to increase in weight reaching 22,100 gms. During the next two months it lost in weight to 20,000 gms. with a marked change in geneal health and nutrition. The appetite was not so good and the sugar elimination reached an average of one and one-half per cent during the fourth month.

Dog No. 9. This animal increased in weight from 11,400 to 12,000 gms. during the sixteen days of normalization. After lesioning in the mid-thoracic region it decreased in weight during a period of two month to 10,000 gms. This animal showed varying abnormal feces sometimes hard and dry and sometimes diarrheal. During this time a slight but constant glycosuria was present.

Dog No. 10. This animal seemed to be perfectly normal in every way and increased in weight during the twelve days of normalization. After lesioning in the mid-thoracic region it gradually lost in weight from 12,000 to 11,000 gms. There was a constant but not severe diarrhoea for thirty-seven days and also a slight but constant glycosuria and poor appetite. After correction of the lesion the dog was then allowed to renormalize for 42 days, during which time the weight increased to 16,700 gms. while the nutrition and appetite were good and other symptoms disappeared.

Dog No. 11. This dog increased from 13,000 to 13,500 gms. during fifteen days of normalization and after lesioning (rotation between the ninth and tenth dorsals) it continued to increase in weight for seventy-eight days but there were no severe physiological perversions of function resulting from the lesion.

Dog No. 18. During nineteen days of normalization this dog gained in weight from 9,800 to 10,900 gms. After lesioning (rotation between tenth and eleventh dorsals) there was a slight decrease in weight but this was neither marked nor progressive. The dog was kept under observation eighty-five days after lesioning during which time there were slight, but no very marked perversions of functions.

Dog No. 33. This dog was a large male, about two years old, weighing 22 kilograms. The appetite was avaricious but nutrition very poor. Examination showed a readily palpable lesion in the mid-dorsal region. This animal

was kept for thirty days under the most favorable conditions but could not be made to increase in weight. It ate twice as much as it should have eaten but frequently vomiting from thirty minutes to one hour after meals. The vomitus showed the contents of the stomach to be almost wholly undigested. It would not gain in weight while in the isolation cage or in the dog room or while allowed to run free and the animal showed an almost constant diarrhoea. The urine showed varying amounts of sugar. The specific gravity was high, but the quantity was low. Traces of albumin and indican were almost constantly present.

The animal was killed and on post mortem, dissection showed a slight rotation between the sixth and seventh thoracic vertebræ. The stomach was found to be distended. The contents had a foul odor and were hyperacidic. A meal consisting of meat and bread which had been given six hours previously was found almost wholly undigested. We have no knowledge as to how this lesion was produced, but we know that it was there when the animal was received and that the above mentioned functional disturbances seemed to result from it.

Unfortunately we lost all of our specimens of tissue which were being kept for pathological examination on this series and therefore have no knowledge of what the changes were.

In our series No. 12, in which the effects of upper and mid-dorsal lesions were studied on monkeys we note the following interesting points:

That "during normalization, all animals either remained constant or gained in weight except No. 11, which lost weight. This monkey had tuberculosis when received."

Monkey No. 5 lost weight from 1,625 to 1,425 gms. during four weeks following lesioning. After lesion was corrected this animal increased in weight to 1,520 gms. in two weeks.

Monkey No. 7 lost weight from 1,020 to 900 gms. during two weeks. Correction of the lesion was not tried.

Monkey No. 8 lost in weight from 2,400 to 2,075 gms. during four weeks and regained to 2,225 two weeks after lesion was corrected. All of these animals were lesioned in the mid-thoracic area, (5th to 10th dorsal).

Monkey No. 9 showed a slight gain for one week and then lost from 1,050 to 925 gms. during the three following weeks. Two weeks after correction of lesion, this animal gained in weight to 1,000 grams, its normal weight.

Monkey No. 12 lost in weight from 2,400 to 2,112 grams during four weeks following lesioning and regained to 2,150 two weeks after lesion was corrected.

Monkeys Nos. 1, 6 and 7 were kept for control; i. e., they were kept unlesioned on the same food supply in the same room with all environmental conditions the same. During all this time Monkey No. 1 showed a constant gain from 900 to 1,000 gms. while Nos. 6 and 7 remained constant in weight.

These animals all showed glycosuria which in some cases was quite marked during the period of lesion. The glycosuria either decreased or completely disappeared after correction of the lesion.

It will be noticed that the monkeys showed a much greater decrease in weight during the period of lesion and that the decrease appeared more quickly after lesioning than in the dogs. This difference is probably due to the fact that monkeys are much more affected by interosseous lesions than dogs. The converse is also true, viz. that monkeys respond to corrective treatment much more quickly and much more completely than any animals we have ever studied. Recently we have been making a careful study of the results of lesion produced (rotation between the eleventh and twelfth dorsals) in five monkeys. There has been a constant albuminuria but no loss in weight during three months of lesion.

In the treatment of our twenty-two monkeys last year (1913-1914) affected with filariasis we have found that the correction of mid and lower dorsal lesions is almost constantly followed by an increase in weight and a decrease in symptoms of the diseases. This would tend to confirm the findings given above, and would indicate that lesions which interfere with the functions of the pancreas, liver, etc., seem to be followed by a decrease in nutrition.

Post mortem made on the monkeys which show a decrease in weight show in practically all cases pathological changes of the pancreas and liver and in some cases pathological changes are found in the kidneys, stomach, intestines, etc.

During the past year (1914-1915) we have observed similar nutritional disturbances in our monkeys as a result of mid and lower dorsal lesions.

To determine whether vertebral lesions have an influence on the development of young animals the following series of work have been done:

On November 20th, five pups about three months old were placed under observation. They all seemed to be in a fair condition except one which was fed on milk for two weeks and improved to normal. They all grew well and increased in weight regularly. They were lesioned in the upper dorsal region (second to sixth) on December 5th. The following table shows the weight in grams during the following month.

	Dec. 5	Dec. 12	Jan. 12
Pup No. 1	6520	6485	8050
Pup No. 2	3800	3800	6015
Pup No. 3	7200	8075	8975
Pup No. 4	8800	8725	9700
Pup No. 5	9000	8025	9900

In another series four healthy pups about six weeks of age were placed under observation all of which were in perfect condition. They were kept in a large clean cage and were given a fresh supply of straw bedding every two days so that they might be clean and dry. They were allowed to run about in the animal room in the yard several hours each day. The following table shows the rate of growth before and after lesion.

Before Lesioning.

	Nov 5.	Dec. 1.	Dec. 30.	Jan. 8
Pup No. 1	4 lb., 3 oz.	5 lb., 4 oz.	5 lb., 12 oz.	6 lb., 6 oz.
Pup No. 2	3 lb., 4 oz.	4 lb.	4 lb., 9 oz.	4 lb., 9 oz.
Pup No. 3	7 lb., 2 oz.	8 lb.	8 lb., 9 oz.	8 lb., 9 oz.
Pup No. 4	5 lb., 12 oz.	6 lb., 10 oz.	7 lb., 5 oz.	7 lb., 12 oz.

After Lesioning.

Jan. 10	Jan. 18	Jan. 24	Feb. 10
Lesioned 2 D.	8 lb., 10 oz.	10 lb., 9 oz.	12 lb., 9 oz.
Lesioned 2 D.	6 lb., 8 oz.	7 lb., 5 oz.	9 lb., 14 oz.
Lesioned 4 D.	9 lb., 5 oz.	10 lb.	
Lesioned 4 D.	9 lb., 10 oz.	10 lb. 5 oz.	12 lb., 9 oz.

We have not as yet made any post mortem studies on the pups and therefore do not know whether any changes

have resulted from the lesions but from the continued growth of these animals after lesioning we are forced to conclude that no immediate changes in function as produced in upper dorsal lesions have resulted which are sufficient to cause any nutritional disturbances.

Summary of Results.

1. Young animals (pups) show very little nutritional change as a result of lesioning; adult animals show more marked changes and old animals show very marked changes.

2. All of the nine pups lesioned in the upper dorsal region continued to gain in weight from one to two months after lesioning. We do not know what the results would be in longer periods of time. as they were not kept longer.

3. Eight of the animals (dogs and monkeys) lesioned in the lower dorsal region gained or remained constant in weight with one exeption.

4. Twelve of the fifteen animals (dogs and monkeys) lesioned in the mid-dorsal (fifth to ninth dorsal) lost in weight, while three remained constant or gained in weight. Twelve monkeys which were suffering from filariasis and treated by correcting lesions of the mid and lower dorsal regions gained in weight.

The loss of weight in these animals could not be attributed to their being kept in cages because control animals were kept unlesioned and only those animals which developed perverted functions lost weight. The greater the functional perversions the greater the loss of weight. Animals do not seem to lose weight until the functional perversions develop; that is, until the normal functioning of some organ or organs essential to metabolism becomes impaired.

5. Monkeys show a much greater decrease in weight during the period of lesion and the decrease appears more quickly after lesioning than in dogs. This difference is probably due to the fact that monkeys are much more affected by interosseous lesions than dogs. The converse is also true, viz., that monkeys respond to corrective treatment much more quickly and much more completely than any other animals we have studied.

6. No loss of weight has been observed in seventeen dogs, lesioned in the innominates nor in the nine dogs and four monkeys lesioned in the cervical region but corrective treatment in the cervical region by which goitres have been reduced has in two cases out of five been followed by much increase in weight.

7. A few animals (six dogs and five monkeys) have been lesioned in the lumbar region but no noticeable changes in nutrition have been observed except in the monkeys, nearly all of which developed diarrhea following the lesioning. In these cases the loss of weight was not great.

Conclusion.

Normal body nutrition depends essentially upon the normal functioning of the various organs which are concerned with digestion, absorption, storage of absorbed products, regulation of metabolism, elimination, etc. Any variation in weight from the normal whether a decrease or an increase, which variation is accompanied by a decrease in body energy and a decrease in body resistance, is to be considered as abnormal.

Ordinarily an increase in weight with the general health remaining normal or being increased is the result of a normal increased condition of metabolism. In this series we have considered an increase in weight to have such a significance.

From the results of this work it would seem safe to conclude that osteopathic lesions have comparatively little effect upon metabolism and nutrition until after they have existed for a sufficient length of time to cause some permanent and marked perversion of function of some of the important viscera concerned in metabolism and nutrition; as for example, the pancreas, liver, stomach or intestines. The same is true of upper dorsal, cervical, lumbar and innominate lesions, but the results of this work show that mild dorsal lesions are most effective.

In many instances the length of time necessary for perverted structural changes to occur in the viscera following bony lesions is not great. McConnell has noted changes in the stomach, pancreas, liver, kidneys, thyroids, and other structures in from ten days to three weeks after

lesioning. We have confirmed these findings and have found that abnormal functions of the kidneys, pancreas, stomach and intestines may be observed in from one to ten days after lesioning. These early perversions of functions such as temporary glycosuria, albuminuria, diarrhea, etc. are not a result of actual pathological change in the structures and are not to be confused with those reactions which cause actual and permanent loss of weight.

It seems, therefore, that we should classify functional perversions, which result from osteopathic lesions into two groups, temporary and permanent. The first symptoms which appear result possibly from an over-stimulated or unbalanced nerve mechanism, due to the irritation of the lesion. These effects, so far as nutrition is concerned, seemed to be temporary and not of any great consequence if the lesion is corrected early.

The immediate effects of the lesion, are however, often quite marked and the resistance of the patient is often greatly reduced. I have observed in animals as well as in humans that there is usually some loss in weight and often much loss of normal functioning. The loss of weight in such cases, I believe, results from an increased irritability, causing an inability to rest (normal sleep) and to recuperate. The wear is increased while the repair processes are decreased. No doubt every osteopathic physician has observed that acute lesions are predisposing factors to certain infectious diseases, as pneumonia, tonsillitis, tuberculosis, influenza, etc. I believe that this increased irritability with its resulting retarded recuperation is one way in which the reduced resistance is caused. The decreased power of recuperation may be considered as being due to a decreased cellular nutrition. That, in fact, is exactly what it is. Decreased cellular nutrition means immediate abnormal cellular functioning. Since all cells are constantly functioning and since all cells are constantly metabolising, any disturbance of their nutrition, of their elimination of cell waste, means structural changes of the cell itself.

The constant demand for normal function requires a continual adaptation of internal structure, function and functional relationships, in the environment both external

and internal. This demand is fulfilled only when each cell constituting the various organs and the regulators of metabolism, the nervous systems and the structures of internal secretion are functioning normally. We must consider all of those factors which constitute the sum total of body function as well as the causes which influence any one part.

We see, therefore, that this is really an organic and not a functional condition. The acute, or the so-called "functional", is but the beginning of the cellular functioning and means perverted function of the organs which these cells constitute. If the causative factors, the lesions, which have produced this so-called functional disturbance are not removed early the result is pathological change in the organs. The result of these changes is marked decrease of function of the organs so affected, and if these organs are particularly concerned with metabolism, such as the pancreas, liver, duodenum, stomach, etc., the loss in weight and body resistance must follow. This then, constitutes the second, or permanent, cause of malnutrition.

Copies of the results of this work were sent to the teachers of physiology and the faculties of all of the osteopathic schools and to a number of practitioners who have been doing clinical research. The following is a summary of the answers received:

"I will agree with you that the so-called osteopathic lesions certainly produce a disturbance in the function of the organs which receive their nerve supply from the region of the lesion, and both functional and organic disease result in the disturbance of nutrition which is brought about by a disturbance of nerve supply.

I think your experiments have demonstrated to a reasonable degree of certainty the effect of osteopathic lesions upon the organs receiving their nerve supply from the regions of the lesion by the disturbed functions of the organs involved. The results seem to be fairly constant and cannot be attributed to any other cause than the lesions.

In young animals lesions do not seem to have much effect for the reason that the nervous system is less sensitive and that the recuperative powers are greater, and inasmuch as they are in the growing period, the lesions are really outgrown. This is a common observation in all young plants and animals." (Geo. M. Laughlin, D. O.)

Dr. Laughlin's idea of the failure of lesions to produce effects in young animals is, we believe, correct. Some young animals, monkeys for example, do react to lesioning.

"Your own conclusion from laboratory experimentation correspond very closely with my observations from clinical experience. I believe you state the facts very well when you observe that the results from the lesion should be divided into temporary and permanent effects.

If our theory of osteopathy is correct we would expect to see function vary from the normal in proportion to the amount of structural perversion, and this is precisely what happens. Lesions that are slight, causing only variations in blood pressure that are soon overcome, show only temporary perversion of function; while those that are more extensive, involving the many functions of the nervous system—trophic, motor, sensory, secretory—produce tissue changes in the organic parts that produce grave disturbances in organic functions.

Thus we have the two types of effects from lesions, those that are minor and soon normalized by nature; and those that are major and require more than nature's power to normalize in order to restore function.

The greatest gain, nutritionally, from osteopathic treatment is toward the latter end of the treatment after the lesions have been in part removed and after function is also in part normalized. This fact corresponds to the conclusion already reached in your laboratory experimentation. Then there are degrees of functional variation from the normal, which are very closely related to degrees of structural perversion. The case does not show rapid gain in nutrition on beginning the treatment for the simple reason that nature looks after the repair of organic structure before she attempts to store up energy. A very practical application of this fact may be made by the patient in resting as much as possible from labor, and thereby allowing a greater amount of energy for repairing the body structure. We must recognize the fact that a great amount of energy is required by the organism to carry on its structural repairs, and when the reserve vitality of the body is low, greater progress may be made in recovery by conserving the energy resources of the organism and thus using them in body repair rather than in performing work.

Nutrition, as I see it, is nothing more than stored energy; and the lesion disturbs nutrition by destroying the mechanism whereby energy is transformed and stored in the tissues. It is *structure,* first, last and all the time, that

must be thought of in contemplating disease." (Orren E. Smith, D. O.)

Dr. Fryette has also raised the question of the intensity of effects from lesions. We do find that the extent of the physiological perversion varies with the amount of subluxation produced.

"Nutrition is too immense a topic to be discussed as a whole. It is influenced by the secretions of all of the digestive organs and by the internal secretions of all of the body, and by the functional use of all and by the storage capacities of some. Just how to take hold of the matter I suppose is the question on which you hope for some light from clinical experience. The ninth and tenth lesion relates evidently to the storage of carbohydrates."

"Your question as to the mechanism by which diseases of nutrition are caused from lesions of the spine brings up the whole question of the effects of lesions. I believe the mechanism to be uniform, the effect depending wholly on the part affected. The lesion causes irritation which results in first stimulation of function, for a greater or longer time according to its degree, which sooner or later has exactly the effect that abuse of function has. At which point it becomes true disease. See recent article by me in the Osteopathic Physician on 'Infective Diseases.' "

There seems to be some law of functional absorbtion evident first in evolution and also in physiology, and I believe, in pathology, whereby the effect of any one lesion is concentrated in one organ; whereas in different persons different organs will be affected from the same lesion." (Ernest E. Tucker, D. O.)

Dr. Tucker's theory of over-stimulation is certainly based upon physiological principles and we are glad to have these various ideas. It is not a question as to whether or not nutrition is affected by interosseous lesions but how is this effect produced.

"Granting that the lesions were sufficiently effective to produce irritation of the spinal nerve roots at those points, I should conclude, as far as this series is concerned, that direct pressure or irritation is not in itself sufficient to cause much disturbance in nutrition.

Also, judging from this and other series which I have closely studied, it would appear that a lesion does not cause any great functional disturbance until it has existed long enough to cause a definite pathological condition, either in some viscus or in the nerve center controlling such viscus.

The fact that practically all the animals show glycosuria should be explained, I think, by the nervous pathology resulting from the lesions.

Your finding that monkeys are more susceptible to interosseous lesions than are dogs, justifies us, I think, in surmising that man is still more susceptible to such lesions.

We know from the study of comparative anatomy and physiology that the cerebro-spinal nervous system reaches its highest development in man, and that as we descend the scale of animal life we observe that the cerebro-spinal system gradually diminishes in importance until it finally disappears entirely, and the animal forms are supplied only with autonomic system.

You ask "what is the mechanism of nutrition?" This is a big question and when we have solved it, we probably will have also found the solution to the question of natural immunity, and a few others upon which the existence of the R. I. depends." (J. D. De Shazer, D. O.)

Dr. De Shazer raises the question of the relation of nutrition to body resistance. We are now at work on this problem and believe it is worth our while. The following will offer evidence of this.

"I have certainly given this subject of nutrition a great deal of thought for the past ten years. It is the *sine qua non* of tuberculosis. While I have tried, theoretically, to fit the osteopathic concept of this disease to the prevailing fashion of medical thought in practice, I have always, in every instance, fought along lines that would increase the assimilation.

You will recall the fact that Wright's opsonin has never been identified. Sajous tried to identify it as an adrenal secretion, and his is the only effort. For my part this defensive compound is pancreatic ferment, its action is but that of a food-cooker-cell-nutrient chemical and other than that of a germ-cooker-cell-product. Get my distinction?

I am persuaded that the osteopathic centre is between the fourth and eighth dorsal and the interference is to the pancreas. The fact that some of your dogs gained in weight is no argument against disturbances of nutrition. Even in some incipient cases of pulmonary tuberculosis, the victim gains in weight without diagnosis or treatment while the pathological lesion is active and growing.

I would explain this phenomenon by saying that the lesion increased by irritation the pancreatic function, and

thereby assimilation was increased, hence the gain in weight." (W. Banks Meacham, D. O.)

So far as I know, Dr. Meacham has done more than any one else along the line of clinical study of the relation of spinal lesions and nutrition and the effects of nutrition on body resistance.

Dr. McConnell, who has been working with us this year and who has had occasion to observe a number of our animals in this series writes as follows:

"It seems to me that your work here touches the basis of the osteopathic concept. That the body is a machine, owing to the fact that there is primarily a transference of energy cannot be gainsaid. Although differentiation of its cells has greatly changed the mechanism and thereby increased complexity and efficiency, still upon broad lines the properties of the primal organization remain. Structural organization is the basis of life phenomena. If the physiology of general metabolism, the body's exchange of matter and energy as manifested by chemical changes in the cell, can be influenced or modified by the interosseous lesion, then no doubt we are dealing with the basic problem of nutrition. This, I believe, is clearly shown by the experiments."

Wm. S. Nicholl of the Philadelphia College writes as follows:

"The results were very interesting and certainly instructive. How can any one question the causative action of osteopathic lesions in diabetes in the face of such evidence?

There was one point in the findings that struck me forcibly. It supports Dr. Earle Willard's contention that the human spine is especially weak and sensitive because of man's having assumed the erect position. I refer to your statement that the monkey was more susceptible to lesions and their effects than dogs and less so than the human beings. There we have the human biped, the dog a bona-fide quadruped, and the monkey a transitional type between the two.

I read the findings to my class in principles, and will take them up in detail when considering the individual spinal lesions and their effects."

The late Dr. L. G. Robb who assisted me in a part of this series of work offered the following suggestions: "The pancreas, stomach and duodenal involvement sounds very reasonable. Alimentary motor insufficiency and pan-

creatic secretory disturbances appear more logical to me, especially the latter. I think the liver is blamed for a little too much. Probably the fault of our Sunday newspapers' science news articles. Although the pups gained in weight after lesioning, I think they showed a distinct retarded development. These results show what may be expected if the lesion exists for a sufficient length of time, dependent, of course, upon the stability of the nervous system of the individual rather than upon any definite period of days or weeks. The results on the monkeys seem to be more constant and the effect more marked, but you would expect even a distant lesion to produce more disturbance in a monkey than a central one in a dog."

Dr. C. W. Johnson writing for the faculty of the Des Moines College:

"We have made more or less study of your report and are favorably impressed with it. We have no criticism to offer except that along favorable lines. The plan of conducting the research-preparation of animals, etc., seems to be suffcient to warrant deductions made by yourself and co-workers. They seem to prove the lines of general observations conducted in our clinic. Therefore we feel that the work is sufficiently conclusive to be placed before the public as reliable matter of information."

It is not surprising to me to find that many osteopathic physicians agree with Dr. Hildreth's fourth dorsal theory of impaired nutrition. The following letter from Dr. Louisa Burns shows, however, that there are other lesions which influence nutrition to a greater extent.

"I have asked several osteopaths, and have looked up some clinic cases concerning the matter.

I have noticed that the tendency among certain authors is to place upper dorsal lesions rather than lower at fault in nutritional disturbances and have been surprised somewhat. For it seems that the upper splanchnic nerves would naturally be the ones concerned and that the spinal centers from which these originate would be the ones to look to in such cases. In these clinic reports, I find the tenth, especially, to be always involved in diabetes mellitus; there are always other lesions but no others have been invariably present. In obesity the eleventh and twelfth have been particularly conspicuous. The gouty form of rheumatism usually includes many lesions, and lower dorsal ones

are always present. Diabetes insipidus has included almost everything in the way of lesions, and they are most erratic. These statements made from clinic reports are in harmony with the statements of several other osteopaths, from their own practice, and are, I think, in harmony with your own conclusions."

Some entirely new features of lesions and their effects in relation to nutrition are pointed out by Dr. H. H. Fryette:

"One of the most interesting facts to me included in this series of experiments is that the lesioned baby dogs and monkeys showed very little bad effects from the lesion, while the adults showed marked symptoms soon and the old subjects serious symptoms immediately. This is quite in keeping with what we find in every day practice. What is the answer to this? I believe it is simply a connective tissue proposition. Because the ligaments in the young are small and weak a lesion does not produce the symptoms that it does in the older subject, but a lesion produces irritation and connective tissue grows when irritated, therefore a lesion that produces no objective symptoms to-day is sure to do so in time.

This immediately suggests a thesis on what might be termed: 'The Evolution of a Bony Lesion', which, of course, would be too long for discussion at this time.

I wish to emphasize one point, however, and that is that human babies and young people, more especially up to the age of twenty-five have a great many lesions that have not showed themselves by producing functional or organic symptoms but they are there, and should be corrected before they develop symptoms, as they surely will if they are allowed to go uncorrected.

It becomes our duty, then, as physicians, to correct every lesion that a patient may have whether they may be causing trouble to the patient at the time or not, just as it is the duty of the dentist to fill every cavity that he may find in the teeth whether they are aching or not."

Quite a number of other letters similar to the above have been received and from the evidence at hand, clinical and experimental, I am still of the opinion that interosseous lesions of the mid-dorsal region from the fifth to the tenth are causative factors in perversions of nutrition.

THE EFFECTS OF AIR IN THE BLOOD STREAM[1]

Series No. 21.

J. Deason, D. O., and H. A. Wendroff, D. O.

The findings in this report came as an accidental result of a more extensive experimental study of the effects of foreign substances in the body fluids. This work is still in progress and will be reported in full later.

Some years ago while doing experimental mammalian work we accidentally found that, contrary to the general belief, a few bubbles of air which happened to get into the veins or arteries of a living animal during surgical operations did not result in immediate death nor did it seem to interfere with the normal physiological processes of the animal. We have recently made a further study of the question with the results which are to follow.

Literature.

Surgical authorities are much at variance as to the effects of air in the blood stream, as may be seen from the following. Of the four dangers of venous hemorrhage, Rose and Carless (Manual of Surgery, 8th Edition) state:

"The entrance of air into veins, which, though rarely met with, is fraught with the most urgent danger to the patient. The air becomes churned up in the cavities of the right side of the heart, forming a spumous, frothy mixture amongst the columnae carneae, which the heart can eject only with difficulty; thus the circulation is brought to a standstill in spite of forcible cardiac contractions, and the patient dies from anaemia of the lungs and brain.

The cause of the entry of air is usually a wound of some vein in what is known as the "dangerous region" of the neck (lower portion) or axilla, or even of such unlikely structures as the pelvic veins or cranial sinuses."

Concerning the signs and symptoms these authorities state:

1 We are greatly indebted to the other workers in the Institute for assisting us with this work, and we are especially indebted to Drs. Hollands and Nicholson for making the post mortem on Animal No. 15.

"If only a small amount has entered, or if the entry is made slowly, no bad results may follow; but the usual effect of the sudden introduction of even a small quantity is to produce severe faintness, and if the patient is conscious, a feeling of dyspnoea and distress, which is partly cardiac in origin, partly due to obstruction to the flow of blood though the lungs. The pulse becomes rapid and almost imperceptible, the pupils widely dilated, and death usually follows, preceded perhaps by convulsions, although the fatal issue may be postponed for a few hours. If the patient survives, no after-effects remain."

These authors class "air-bubbles among the common causes of "Simple Emboli." Concerning the dangers of external wounds of the head, these authors state that "Infective thrombosis and pyemia are the chief dangers, but entrance of air has also led to a fatal issue in a few cases."

From Da Costa (Modern Surgery, Sixth Edition) we quote the following:—

"*Air-Embolism.*—Air may enter a vein during a surgical operation, it may be injected accidentally while giving a hypodermic injection, hypodermoclysis, or a saline infusion into a vein. It may follow irrigation of the pleura with hydrogen peroxid. In caisson disease it is taught by some that nitrogen is set free in the blood. It may occur when a cerebral sinus is opened, or in the uterine veins, if the uterus does not remain contracted after delivery. It is very seldom that any symptoms follow. It was long thought that such an accident must be extremely dangerous. The experiments of my colleague, Professor Hare, indicate that quantities of air may be injected into the veins of a dog without apparent harm. The entry of a small amount of air into the veins of a human being will not be apt to induce dangerous symptoms, but it may be fatal. The more rapidly it is introduced and the greater the amount, the greater is the danger. The manner in which it can induce death is doubtful. Some maintain that it causes blood in the right side of the heart to froth, and thus prevents normal action of the valves, the heart becoming unable to propel blood through the lungs. Others maintain that air reaches the cerebral capillaries and so causes cerebral anemia. Some believe cardiac failure results from the presence of air in the pulmonary capillaries. The first is most probable. If a surgeon divides a large vein, air may be sucked in, and there is particular danger in such an accident if a vein at

the root of the neck or a cerebral sinus is torn or incised, or if the damaged vessel lies in scar tissue and cannot collapse."

Under the Symptoms of this Condition Da Costa States:

"When during an operation air enters a large vein there is a sucking sound, air bubbles may be noted in the wound, and serious symptoms may or may not follow. Twice I have wounded the subclavian vein and have heard this sound, but no alarming symptoms developed. If serious symptoms are produced, they arrive suddenly, and consist of extreme failure of circulation, a curious whirring or churning sound on cardiac systole audible even without a stethoscope, deadly pallor or cyanosis, gasping for air, convulsions, and possible death."

All of the other literature that we have been able to find on the subject is very indefinite and offers little other than what has been given above, and we have not been able to find any statements regarding the effects of air entering the arteries from accidental injury, but in experimental work there is some danger if the air be allowed to enter the peripheral end of the artery as will be seen from our results.

Methods of Study and Results.

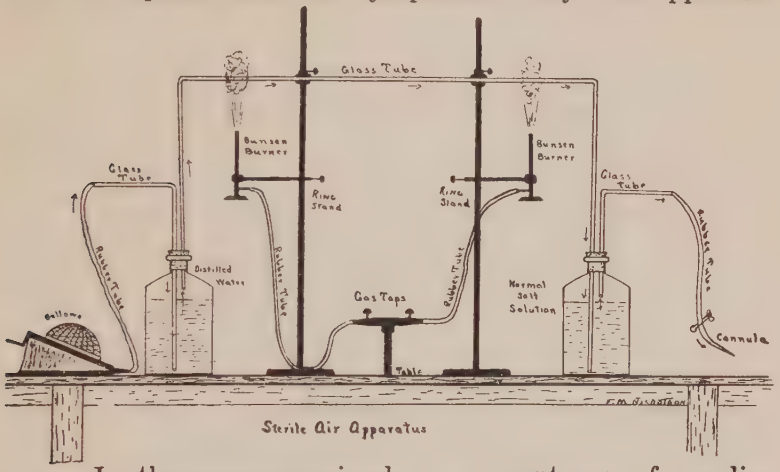
The first six animals that were operated on had varying quantities of air, from one to ten cubic centimeters, injected into their veins and were kept for from one to two hours usually under ether, after the air had been injected.

It is known that even small amounts of most foreign substances, especially solids, will cause coagulation when injected into the blood stream. For this reason we carefully washed all of the air used for injecting by bubbling it through distilled water and sterile physiological salt solution. This was later found to be unnecessary and that the injection of unwashed air was not followed by coagulation or any other bad effects. The injection was usually made into the femoral vein by means of a glass cannula attached to a burette.

For the purpose of determining more definitely the effects of such injections of air the following experiments were performed:

Dog No. 7. An injection apparatus was arranged by means of which small bubbles of air were first pumped through distilled water, and then bubbles through physiological salt solution before it was injected into the vein. The air thus washed, sterilized and rewashed was pumped into the central end of the femoral vein. The animal was kept under anesthesia and the operation was done aseptically. From fifty to one hundred c. c's of air were thus injected during a period of ten minutes.

After the injection was made the vein was ligated and incision was stitched and bandaged. The animal was kept and carefully observed for a period of three weeks after the operation and no symptoms of any kind appeared.



In these seven animals no symptoms of cardiac troubles were observed and there were no signs of inability of the heart to pump blood to the lungs. There was no dyspnea nor signs of cerebral anemia. Post-mortem examinations of the first six animals showed no frothy blood in the heart and no signs of air or emboli in the lungs. The fact that we found no air in the veins, heart or lungs in post-mortems made from thirty minutes to two hours after the injection of air into the veins leads us to conclude that the air is all removed from the blood as it passes through the lungs and that probably some of it is absorbed directly by the blood in the veins. If this is true there is no danger of cerebral emboli from the entrance of air into the veins.

For the purpose of determining the effects of other foreign substances when injected with air, suspensions of

small quantities of insoluble salts, such as bismuth subnitrate and bismuth subcarbonate were made in physiological salt solution, and this injected into the central end of the femoral vein together with air bubbles. These injections were followed by rapid and forceful heart beats, usually dyspnea and death.

The symptoms appeared in from a few seconds to two or three minutes after injection. Post-mortem examinations showed that the blood had coagulated in the veins and heart. Bubbles of air were found in the veins and heart together with clotted blood. These results would seem to show that the fast, forcible and irregular heart beats, the dyspnea, etc., observed by surgeons, may have resulted from foreign substances other than air causing clot emboli.

To determine whether air, when injected into the arteries would cause any bad effects, four dogs were operated as follows:

The animal was carefully etherized and the ventral portion of the neck was shaved and sterilized; first by scrubbing with warm water, soap and brush following, when alcohol and tincture of iodine was freely applied. An incision was made in the median line of the neck, and the carotid sheath carefully lifted from its place without straining on the vagus nerve. From one to two c. c.'s of air were injected into the carotid artery without removing the carotid sheath. The needle was inserted brainward and the injection made without disturbing the surrounding tissues. There was usually some hemorrhage from the artery after the needle was removed, but this was easily stopped by the application of a drop of alcohol. The structures were then replaced to their normal position, the incision was sewed and the parts bandaged. These operations were all done aseptically and no infection resulted in any case. In two dogs sterile air was used for the injection while in the other two animals nonsterile air was used. These animals were kept for from one to two weeks and with one possible exception there were no symptoms from the injections. One animal was observed to vomit twice after eating on the day following the operation, but this might have resulted from ether sickness or some other cause.

Dog No. 15. This dog was about three years old and seemed to be well nourished and otherwise in good condition except that it had incoordination of the hind legs. There was no spasticity and the animal could walk some when placed on its feet and given a start. After two weeks observation the animal was observed to grow worse and refused food. An open operation was performed as described above, two c. c.'s of sterile air into the right carotid artery. The operation was performed at 9 P. M. The dog did not regain consciousness after the effects of the ether had passed, but went into coma from which it never recovered. Spasmodic clonic contractions of the diaphragm and abdominal muscles were observed as soon as the effects of the ether had passed away. There was also extreme dyspnea, rapid heart beat (204 per minute), tonic spasms of the eyelids and dilated pupils. We cannot say that all of these symptoms resulted from the injection of the air as the animal was observed to have spasmodic contractions of these muscles before the injection was made. The next morning the dyspnea and spasmodic contractions were less marked, the eyelids were partly open, and there was marked nystagmus. The pupils did not react to light, vision and sensation seemed to be lacking but the lid reflex was present.

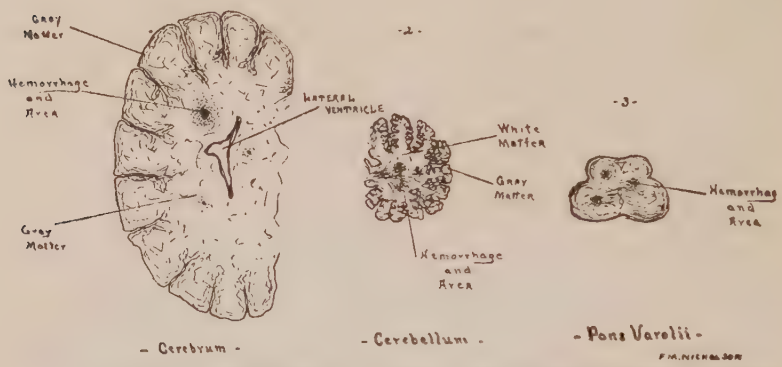
The animal was given one pint of water by stomach tube. There was no tetanus of the jaw or other muscles and the evacuation of the bowels and bladder seemed to be normal, occurring once or twice daily. The clonic contractions and dyspnea became less severe during the day and twenty-six hours after the operation there seemed to be a slight response to sensory stimuli, but no sensation. The nystagmus had stopped, the heart beat and respiration were about normal and the clonic contractions of the abdominal muscles and diaphragm were less marked. The animal was again given water by stomach tube. Death resulted about thirty-two hours after the operation.

Post-mortem Findings.—There was some inflammation in the region of the incision but neither of the vagi or phrenics were found to be injured in any way. The inflammation had involved both carotid sheaths and it is possible that the nerves could have been affected by the inflammation. We believe, however, that the symptom came as a result of brain anemia.

A careful dissection of the spinal structures showed that there was no fracture or luxation as we had suspected, but instead there was a characteristic interosseous subluxation between the tenth and eleventh dorsal vertebræ, the tenth being rotated to the right. The tenth and eleventh

ribs on the right side were approximated and the corresponding ribs on the left side were separated and posterior. There was no fracture of any part of the vertebræ or ribs.

The brain was carefully removed and placed in a formalin solution. After ten days it was sectioned and showed numerous small hemorrhagic areas in the cerebellum and pons varolii. The left side of the cerebrum showed one area of clot with surrounding tissue infiltrated with blood internal to the anterior horn of the left ventricle. A few smaller areas of infiltration were found.



In our experimental work we have twice before observed symptoms of incoordination resulting from bony lesions. Drs. McConnell, J. H. Baughman and others tell us that they have observed such symptoms from bony lesions and that such cases respond well to treatment.

Dog No. 16. Because the results of the above tests were unreliable, due to the bad condition of the dog at the outset we decided to try a normal dog with larger amount of air. A perfectly healthy animal weighing about 17 kg., was therefore, injected with three c. c.'s of air into each carotid artery with results as follows: The animal regained consciousness in about three hours after the operation, but the eyelids were tightly closed. There were no other symptoms such as those which occurred in Dog No. 15, except cerebral anemia. The respiration, pulse, and temperature remained normal. The muscle tone was good and the reflexes all seemed to be present and normal. After nine hours (the morning after the operation) the animal seemed to be more conscious, responded to calls by waging its tail and lifting its ears but would not try to stand.

The eyes were open and the lid and pupillary reflexes seemed to be normal. It refused food and drink, but was

given water by a stomach tube. There was no paralysis or incoordination at any time. The dog was allowed to remain undisturbed and the following morning it seemed much more active, responded to calls, ate and drank and passed urine and feces normally. It stood or sat up a part of the time and showed no signs of incoordination. The following day (three days after the operation), the animal seemed to be almost normal in every way. There was no infection from the operation and so far as we could observe the animal was normal in every way.

When the animal was removed from the cage and allowed to run free it was found to be unable to see. We have not yet determined the cause of the blindness. All of its other senses seemed to be normal. It is now five days since the animal was operated.

Conclusions.

1. That there is very little or no danger from the entrance of air into the peripheral veins unless other foreign substances are carried in with it.

2. That blood of normal animals has the power of absorbing large quantities of air and that it can also destroy bacteria which may be contained in the air.

3. That air injected into the carotid arteries will cause anemia of the brain from which the animal may recover if kept quiet.

4. That symptoms of incoordination can result from interosseous subluxations.

A STUDY OF THE INTERVERTEBRAL FORAMEN AND CONTIGUOUS TISSUES

F. M. NICHOLSON, D. O.

SERIES NO. 22.

Through conversation with members of the profession, who visited the Institute, especially those who had been out in the field for a number of years, and from reading the literature of the profession, it became evident that the interest along the lines of establishing a true fundamental principle to explain the theory of the lesion, its causes, its pathology, its effects, and the mechanical principle involved in correcting it was foremost in the mind of every physician and the one he most desired to see made a subject of research. Dr. McConnell's association with the Institute, the work he had already accomplished since 1905, and his desire to have research work done in other phases, prompted the Institute to begin work along this particular line with the idea of making it exhaustive in every phase so that we might have a thoroughly founded basis upon which to work.

It was at first suggested that the histology of the spinal foramen and the structures in relation be studied; that these studies be carried on with cervical, dorsal and lumbar specimens, and in specimens of many animals, different kinds of animals, young and old, and embryos; the intravertebral discs, their development, histology, whether or not there is contractile tissue, nerve fibers, vessels, blood and lymph, and also to be carried on in all kinds of animals of various ages. A few of the problems suggested with the above were: Does acute spinal lesion cause cord congestion? Does acute spinal lesion cause congestion in spinal foramen and disc? Does acute or chronic spinal lesion have any effect on the spinal ligaments and other tissues?

The above, at first, presented itself as a confused problem because the obstacles that made themselves most

conspicuous were, where and how shall such a work be begun and what shall be the technique for such a study?

Looking at the problem generally, it was, of course, significant that the normal be studied first and then study the tissues as associated with lesions.

Literature. We wish to let it be known that this report is only in brief and introducing but the beginning in this work. The important statements only, are made here and the series will be written in detail and with discussion in a future bulletin.

Up to date, there is no literature dealing in detail with the microscopic study of the spinal foramen with its structures intact. True, the anatomists and histologists have studied each structure separately and evidently not to any great extent.

In Dr. McConnell's work he has studied the pathology of the various tissues and organs in relation with lesions.

Regarding the study of the spinal cord, much has been done. Dr. McConnell, in all his work, has studied the tissues involved by lesions and has given his findings to the profession. He found degeneration of nerve cells in the spinal cord, degeneration of axones and degenerations in the posterior ganglion. He also found congestion and degeneration of the various organs supplied by nerves from the lesioned areas as well as pathological changes in the muscles in relation to the lesion. The medical text books, of course, tell us about the findings in connection with the various affections of the spinal cord known to medicine but they have nothing regarding the lesions of the vertebral column as affecting the cord and other tissues. Deason and Robb found no evidence of direct pressure in a series of work on innominate lesions.

Chromatolysis has been found in many cases and in experimental work showing the effect of fatigue toxins upon its nerve cells.

Methods of Technique. Animals were secured, dogs, rabbits, rats, guinea pigs, and monkeys and normalized for several weeks, examining them to be sure that they had no lesions, at least they were not marked and if any were

present, they were so slight that methods of examination failed to detect them. The animals were killed outright, giving them ether or chloroform to a degree beyond surgical anesthesia. The spines were dissected out and the ribs cut off and then the segments from the cervical, dorsal, and lumbar areas were carefully procured. Care was taken so as not to injure in any way the vertebrae since the cord was to be studied.

In doing this the finest of instruments were used and work was carried on under great precautions. The spinal muscles, all ligaments, cord, spinal nerves, and other structures were left intact and handled in a manner so as not to injure them.

The usual methods for fixing and preparing the tissues for microscopic study, staining, and mounting were used. In this the technique was changed somewhat, increasing the number of alcohols used and lengthening the time in each alcohol.

Technique for Histology and Pathology

1. Anesthetising animals.
    1. Put under bell-jar and insert chloroformed cotton. If animal is large give 6 c. m. of 1% sol. morphine muriate subcutaneously.
    2. After chloroformation for ½ hr. open chest and stop heart.
    3. Get specimen within 12 hrs. of living condition.
2. Procure specimen 1 c. m. (fresh to 12 hrs.)
3. Wash in normal NaCl.
4. Fixation.
    1. Put in 7.5% Nitric Acid sol. 4 to 6 hrs.
    2. 70% alcohol to remove acid.
    3. Wash in running water, 6 to 24 hrs.
5. Decalcification.
    1. 5% HNO—2 to 10 days, changing solution in large quantities every day.
    2. 10% formalin (changed frequently) 24 hrs.
    3. Running water—24 hrs.
6. Dehydration and saturation.
    1. 10% absolute alcohol, 12 hrs.
    2. 20% absolute alcohol, 12 hrs.
    3. 30% absolute alcohol, 12 hrs.
    4. 40% absolute alcohol, 12 hrs.
    5. 50% absolute alcohol, 12 hrs.
    6. 60% absolute alcohol, 12 hrs.
    7. 70% absolute alcohol, 12 hrs.
    8. 80% absolute alcohol, 12 hrs.
    9. 90% absolute alcohol, 12 hrs.
    10. 100% absolute alcohol, 12 hrs.
    11. 100% absolute alcohol, 12 hrs.

a. Paraffin.
   1. 3 parts absolute alcohol and 1 part chloroform, 6 to 12 hrs.
   2. 1 part absolute alcohol and 1 part chloroform, 6 to 12 hrs.
   3. 1 part absolute alcohol and 3 parts chloroform, 6 to 12 hrs.
   4. Pure chloroform, 12 hrs.
   5. Pour off all chloroform but enough to cover specimen.
   6. Add a few sticks soft paraffin and put in thermostat. (Continue to add when melted and leave for the night. Chloroform evaporates at the same time.)
   8. Transfer with heated spatula.
   9. Leave in hard paraffin, 2 hrs.
   7. In meantime prepare melted hard paraffin.

b. Celloidin.
   1. Equal parts of alcohol and ether.
   2. Thin celloidin several days.
   3. Thick celloidin 1 to 5 days
   4. Stock celloidin 1 to 5 days.
   5. Place on block.
   6. Expose to air a few seconds.
   7. 75% alcohol, 1 day to indefinitely.
   8. Absolute alcohol for several hours just before cutting.

8. Embedding.
   1. Put specimen in boxes lined with vaseline.
   2. Place in cold water 1 to 3 hrs.

8. Sectioning.

9. Mounting.
   1. Place in albumo-glycerin sol. on slide.
   2. Heat over flame.
   3. Place slide in thermostat or in bath 1 to several hrs.

10. Staining.
   a. Paraffin:
      1. Xylol 1 to 5 min.
      2. Absolute alcohol 1 to 5 min.
      3. 90% alcohol 1 to 5 min.
      4. 80% alcohol 1 to 5 min.
      5. 70% alcohol 1 to 5 min.
      6. 60% alcohol 1 to 5 min.
      7. 50% alcohol 1 to 5 min.
      8. Water 1 to 5 min.
      9. Hemotoxylin 1 to 5 min.
      10. Water 1 to 5 min.
      11. Eosin few seconds.
      12. Water 1 to 5 min.
      50% alcohol, few seconds.
      60% alcohol, few seconds.
      70% alcohol, few seconds.
      80% alcohol, few seconds.
      90% alcohol, few seconds.
      100% alcohol, few seconds.

   b. Celloidin.
      Hemotoxylin, 1 to 5 min.
      Wash in H_2O.
      Eosin few seconds.
      Wash in H_2O.
      50% alcohol few minutes.
      75% alcohol few minutes.
      95% alcohol few minutes.

11. Cleaning.
    1. Put slide or specimen in oil or origanum or xylol, 1 to 5 min.
12. Preservation.
    1. Blot slide.
    2. Put on Canada balsam.
    3. Put on cover slip.

The celloidin method was used because of the size of the specimens necessary for study of section across the foramen and the tissues in relation. In the study of the spinal cord the Nissl method was followed. Then the specimens for study of foramen were cut in two, antero-posteriorly and mounted on blocks, the celloidin hardened in 75% alcohol for several days and then in 95% just before sectioning and staining and then stained by basket method and studied. The staining was done with hemotoxylin and eosin, according to the following outline on technique.

For the study of nerve cells, Nissl's method was used.

1. Fresh tissues hardened in 90% alcohol.
2. Transferred to solution of 98% alcohol.
3. Imbed in paraffin.
4. Section.
5. Mount on slide.
6. Stain in Nissl methyline blue.
7. Wash in solution of 90 parts absolute alcohol and 10 parts analine oil, until no more color is given off.
8. Blot.
9. Put in oil of cojuput to clear.
10. Blot and wash with benzene.
11. Mount and study.

In the study seven tissues were always observed.

1. The bone and cartilage about the foramen.
2. The fibrous connective tissue lining the foramen.
3. The nerve.
4. The artery and veins.
5. The supporting tissue in the foramen.
6. The relative percentage of the foramen the structures occupy.
7. The articulation of the facets and their approximation.

Description and records were always kept separated as follows:

a. Cervical
b. Dorsal
c. Lumbar

This was studied with tissues in which there was palpated no distinguishable lesion. A study of the lesion has been started, but it is not completed at this time.

Results. (1) In the cervical region there are found as the frame of the foramen, (depending upon the place of sectioning) consisting of fibrous cartilage surrounded by spongy bone, and wherever the section was not through bone, that is more laterally, connective tissue, muscle, fat tissue and the head of the rib. The same was true of the dorsal and lumbar regions. The amount of each tissue depending upon the place of sectioning—the distance laterally from the cord.

(2) In the cervical region we found the fibrous connective tissue lining of the foramen increasing in thickness as their order given from above down and the number found in each.

Area	No. of specimens	.025 m. m.	.037 m. m.	.05 m. m.	.062 m. m.	.075 m. m.	.087 m. m.	.1 m. m.	.112 m. m.	.125 m. m.
Cervical	51	3	7	7	3	1	11	5	2	6
Dorsal	67	3	11	9	5	0	16	11	2	4
Lumbar	60	2	6	9	9	7	15	1	5	3

(3) The nerves in the foramen were carefully studied and characteristics according to the following tabulation were found:

Region	No. of specimens	too poor for study	normal large nerve	1 filament	2 filaments	3 filaments	4 filaments	5 filaments	6 filaments	7 filaments	10 filaments	Many filaments	2 nerves	3 nerves	thick peri	thick peri	Closely imbedded in perineurium
Cervical	51	7	12	6	2	1	1	0	0	1	0	1	4	0	3	0	12
Dorsal	67	5	15	11	7	2	2	2	2	1	1	0	2	4	5	0	15
Lumbar	60	4	26	2	5	0	2	1	1	0	1	1	0	4	0	4	13

(4) A careful survey of the arteries and veins in the foramen was made and the following table shows the findings:

Arteries.

	NORMAL								PATHOLOGICAL			
Region	No. of specimens	too poor to study	No. arteries	1 large	1 small	2 small	3 small	4 small	small congested	large congested	2 small congested	3 small congested
Cervical	51	7	23	4	10	4	0	1	1	0	0	0
Dorsal	67	5	27	11	19	1	0	0	1	3	0	0
Lumbar	60	4	25	0	12	1	1	0	2	3	2	1

Veins.

	No. of specimens	too poorly stained to study	Normal 1-5 veins	Congested 1-5 veins	Normal 5-10 veins	Congested 5-10 veins
Cervical	51	7	24	16	3	2
Dorsal	67	5	33	17	6	2
Lumbar	60	4	27	17	7	3

(5) The supporting connective tissue in the foramen was studied carefully but briefly. The following points of interest were found.

Region	No. of specimens	too poor to study	*	2*	3*	4*	5*	6*	7*	8*	9*	10*	11*
Cervical	51	7	3	3	5	3	1	2	3	12	1	3	6
Dorsal	67	5	1	6	6	3	1	5	9	11	8	6	6
Lumbar	60	4	3	3	6	4	4	2	12	7	8	3	3

* (These increase in density as per their order shown by the use of (*). Evidently the normal is shown at 8*.

(6) In each specimen we studied and estimated as best we could the percentage of the foramen taken up by the structures as a whole,—the nerve, artery, and veins. The following is the way we found it.

Region*	100	95	90	85	80	75	70	65	60	55	50	45	40	35	30	25	20	15
Cervical			23	6	6	3					4							
Dorsal	1		9	10	12	12	2	4			8			1				1
Lumbar		1	4	6	10	4	2	2	15		3			3		1	1	1

* The numbers show the percentage.

(7) The articular surfaces were studied in each specimen whether they were approximated normally, that is, the length of one approximated upon the length of its fellow, or if there was rotation between the two particular vertebrae, resulting in the development of the facets from their normal. In each specimen we considered the upper vertebrae as fixed and the one below as the one moving. If the upper facet of the lower vertebrae was displaced forward and upward on the lower facet of the vertebrae above, we considered it as extension into the foramen and if down and back, as retraction from the foramen. When the approximation was normal the capsular ligaments on each end were relaxed, and if there was retraction or extension the capsular ligaments were tightened on both ends as would seem naturally. This movement however is normal so long as the ligaments are not ruptured.

Region	None found	Normal	Slight retraction	1-5 extension	Separation	Marked extension	Slight extension	¼ extension	1-3 extension	⅓ extension	½ retraction	⅔ retraction
Cervical	20	24	2	1	1	1	3					
Dorsal	11	42	2				9	1	1	1		
Lumbar	13	32	2		4		4	1		1	2	1

After having carried on the experimental work on the foramen for sometime and finding some conditions which seemed to be abnormal and probably in direction of lesioned condition, it was of course well in order to get the nerve tissue of the segments of the cord in relation with the segment in lesion and study the nerve cells.

In this the animals were lesioned in various areas, using different kinds of animals, and leaving the lesions for different periods of time.

The lesion was always produced by putting the animal under ether anesthesia and then producing a rotation.

In killing, the animal was subjected to surgical anesthesia, the lesion palpated and confirmed by other workers present. The skin was dissected off, then the muscles and finally the ribs were carefully dissected and after each step the lesion was examined to see if it was still present.

The cord was dissected from the bony column, leaving the spine intact so as to avoid correction of the lesion; then the lesioned vertebrae were cut out and labeled with all necessary data. Nissl method of technique was used for the bony segments.

The following interesting results were found and are here given showing percentage of chromatolysis of nerve cells:

1. Cat. Escaped.
2. Dog. Put on another series.
3. Dog. Lesioned at 9D and 2L and killed 11 days after lesioning.
   7D showed 77% chromatolysis.
   9D showed 86% chromatolysis.
   12D showed 62% chromatolysis.
   2L showed 73% chromatolysis.
   4L showed 83% chromatolysis.
4. Dog. Lesioned 9D for 11 days, showed 57% chromatolysis.
5. Dog. Lesioned 6D for 43 days,
   5D 69% chromatolysis.
   6D 64% chromatolysis.
   10D 50% chromatolysis.
6. Dog. Put on another series.
7. Dog. Put on other series.
8. Guinea pig. Put on other series.
9. Guinea pig. Died of infection of jaw and there was complete chromatolysis.

10—14. Guinea pigs. Put on other series.

15. Guinea pig. Lesioned in lower cervical—showed 77% chromatolysis.
16. Puppy. Died from unknown cause other than an infection, showed 36% chromatolysis.
17. Guina pig. Died of unknown cause, showed 47% chromatolysis.
18. Dog. Lesioned in 1L for 24 days, showed 50% chromatolysis.
19. Dog. Killed by ether accidentally, showed 37% chromatolysis.

20. Monkey. Died from exhaustion.
9D 33% chromatolysis.
11D 77% chromatolysis.
13D 30% chromatolysis.
21. Dog. Lesion (chronic) 9D.
7D 30% chromatolysis.
9D 52% chromatolysis.
11D 54% chromatolysis.
22. Dog. Lesioned 9D.
7D 30% chromatolysis.
9D 36% chromatolysis.
12D 44% chromatolysis.
23. Rabbit. Not lesioned. Died of infection. Showed 64% chromatolysis.
24. Dog lesioned 10D.
9D showed 35% chromatolysis.
10D showed 66% chromatolysis.
11D showed 52% chromatolysis.
25. Dog. Not lesioned, killed for other work, 26% chromatolysis.
26. Dog. Lesioned in 7D for 1 day.
4D showed 8% chromatolysis.
6D showed 8% chromatolysis.
13D showed 16% chromatolysis.
27. Dog. Lesioned 6D. Killed.
2D showed 48% chromatolysis.
6D showed 50% chromatolysis.
10D showed 50% chromatolysis.
28. Guinea pig. No lesions . Cause of death unknown.
1D showed 100% chromatolysis.
6D showed 83% chromatolysis.
12D showed 92% chromatolysis.

Conclusions.

1. That there is a normal condition for the various tissues about the foramen.

2. That, with more work, a norm could be learned, to be used as a basis for study in pathology.

3. That there is a variation in the frame work in the different areas of the vertebral column.

4. That the fibrous connective tissue lining of the foramena increase in thickness in more specimens from the cervical to the dorsal region and that it decreases again in the lumbar.

5. That the nerves are more complex and have more filaments and thicker perineurium in the dorsal region.

That the spinal arteries are more prominent in the dorsal region.

7. That there are more veins in the dorsal region.

8. That there are tendencies toward congestion with abnormal conditions of the spine.

9. That the supporting tissue in the foramen is fairly constant in thickness in the three areas.

10. That the structures occupy a greater percentage of the foramen in the cervical region, less in the dorsal region and least in the lumbar region.

11. That there is an increased chromatolysis in nerve cells in connection with lesions.

EXPERIMENTAL STUDY OF RENAL SECRETION

A. Hollands, D. O.

Series No. 23.

Purpose.

The purpose of this work was to determine whether the functions of the kidneys in animals could be affected under normal condition by manipulative treatment of the so-called kidney area of the spine.

Method of Study.

Two small female dogs about two years of age were selected and kept under careful observation for a period of four weeks. Samples of urine were taken from two to three times a week and analyzed to determine whether any abnormal condition of the kidneys existed. After these animals were found to be perfectly normal in every way they were isolated in clean cages the floor of which consisted of galvanized hardware cloth which prevented any solid matter from passing through. Beneath this floor a galvanized pan is suspended for collecting the urine free from all solid matter and draining into a clean cup.

The dogs were kept in these cages for twelve hours (during the night) and allowed to run free in the yard during the day. This was done that we might study these animals under perfectly normal conditions. The food consisted of a regular mixed diet which was kept constant during the period of normalization and during the period of the test. The cages were thoroughly cleaned, dried and ventilated during the day so that the samples obtained would be reliable. Urine was collected for two successive days and an average of the quantity and specific gravity of the amount voided during this time was taken. On the third day the dogs were treated by giving manipulative treatment applied to the tenth, eleventh, and twelfth dorsal segments of the spine every two or three hours. This treatment was applied for from one to three minutes and was

intended to get good movement in these segments without influencing other parts. The urine was collected during the following twelve hours and the quantity and specific gravity compared with the samples previously taken.

Results.

Dog No. 1.

	Sample before treatment		Sample after treatment	
	Spec. Grav.	Quantity.	Spec. Grav.	Quantity.
	1.039	75 c. c.	1.065	120 c. c.
	1.050	98 c. c.	1.060	130 c. c.
	1.050	80 c. c.	1.065	140 c. c.
Average	1.046	84 c. c.	1.063	130 c. c.

Dog No. 2.

	Sample before treatment		Sample after treatment	
	Spec. Grav.	Quantity.	Spec. Grav.	Quantity.
	1.050	150 c. c.	1.065	180 c. c.
	1.055	55 c. c.	1.065	50 c. c.
	1.045	37 c. c.	1.060	100 c. c.
	1.040	100 c. c.	1.060	140 c. c.
Average	1.047	85.5 c. c.	1.062	117.5 c. c.

During this period of observation four samples (two on each dog) were taken before and after treatment and the results showed similar differences in quantity and specific treatment.

Conclusion.

Since these animals had been kept for a long period of time under my personal observation daily, I feel sure that these results could not be attributed to fright from handling or from any other accidental cause. I am convinced that the results came from the effects of the treatment, probably an increased functional activity of the kidneys due to an increased nerve force due to an increased functional activity of the nerve cells in the cord which in turn may have been caused by an increased blood supply to those segments of the spine as a result of the manipulation.

We are not reporting this work as conclusive by any means, because we realize that a much greater amount of experimental work along this line is needed before these results could be confirmed.

AN EXPERIMENTAL STUDY OF RENAL OUTPUT

Drs. Hollands and Nicholson.

Report from

The A. T. Still Research Institute.

Series No. 24.

In this series which is the continuation of the results accomplished from Series No. 16, which was reported in the March edition of the Journal of the American Osteopathic Association, Volumn XII, No. VII, 1913, and was the work of much effort on the part of Dr. J. Deason and his assistants.

The object of this series is to determine the output from the kidneys, both from the standpoint of fluid and solids as influenced by osteopathic measures, and to determine a specific center for kidney control. Is the kidney center (osteopathically speaking) in the tenth, eleventh, and twefth spinal segments, or is it specifically in the eleventh and twelfth segments? The profession as a whole, has long realized and feels convinced that treatment in the lower dorsal area has a decided effect upon the output from the kidneys in various bodily ailments, where an increase in elimination is desired.

The best authorities on research in physiology have proved that the output from the kidneys is directly proportional to the amount of arterial blood to the glomeruli and secreting tubules, that the amount of solids eliminated is directly proportional to the output of fluid, and also, that the amount of output from the kidney varies directly with the systemic blood pressure.

The ratio of the arterial supply to the glomeruli, to the venous drainage from the glomeruli is as 2 to 3, or more specifically speaking, the lumina of the vasa efferentia is two-thirds of the size of the lumina of the vasa afferentia. It has been definitely proved that the osmotic pressure

within the secreting tubules, is about 30 m. m. of Hg. less than the osmotic pressure within the glomeruli, between Bowman's capsule and vasa afferentia entering the glomeruli, which are about 20 m. m. of Hg. less than the systemic blood pressure.

If the pressure within the tubules is raised 30 to 40 m. m. of Hg., the secretion of urine stops, which has been proved by ligating the ureters. Also, if the general systemic blood pressure is lowered 40 to 50 m. m. of Hg., the secretion stops.

It is accepted by the authorities, Cushny, Osler, Emerson, and Starling, that ether does not increase the systemic blood pressure, and that it does not increase the amount of output of solids. Cushny states that there may be a slight diminution in secretion. Emerson states that there may be a slight diminution in solids. These statements have been corroborated by Dr. J. Deason and Dr. L. G. Robb.

This series is being conducted upon etherized animals.

The animals used in this series are dogs, either males or females, of the average size and of seemingly perfect health. The animals are kept under careful observation and normalized for a period of several weeks. By this time the dog becomes adapted to the surroundings, thus minimizing all possibilities of shock and excitement when it is taken to the operating room. The dog is immediately anesthetized and placed upon the operating table. While one operator inserts the tracheal cannula, the other performs the abdominal incision, and cannulates both ureters about one inch from the bladder. The time and number of the drops are taken and immediately weighed to determine the specific gravity. Manipulation is then performed in the region of the eleventh and twelfth dorsal, and after a suitable period of time, the time and number of drops are again taken, weighed and compared with the first. In some instances a second manipulation is performed and the results are compared with the second sample taken.

The following results have been obtained to date:

Animal	Rate of Flow Drops—Minutes		Weight of one c. c. of urine
Dog. No. 1.			
Before manipulation	20	27	1.032
After manipulation	44	30	1.050
Dog No. 2.			
Before manipulation	26	28	1.020
After manipulation	26	26	1.066
Dog No. 3.			
Before manipulation	15	31	1.053
After manipulation	15	17	1.043
Second manipulation	15	47	1.049
Dog No. 4.			
Before manipulation	36	5	1.027
After manipulation	25	5.5	1.033
Second manipulation	33	5	1.035
Third manipulation	30	13.5	1.040
Dog No. 5.			
Before manipulation	40	7.5	1.021
After manipulation	40	9.5	1.016
No further manipulation	40	11	1.026
Second manipulation	40	13	1.027
Dog No. 6.			
Before manipulation	49	13	1.057
After manipulation	50	25.5	1.078
Dog No. 7.[1]			
Before manipulation	20	12	1.044
After manipulation	20	25	1.044
Dog No. 8.[2]			
Dog No. 9.			
Before manipulation	40	9	1.020
After manipulation	40	9	1.038
No further manipulation	40	15	1.043

1. The spine of this dog was very rigid and no motion could be obtained on manipulation. This probably explains that the osteopathic lesion (rigidity) interfered with the normal nerve impulses which should have resulted from the manipulation.

2. In this animal we were unable to obtain any flow of urine whatsoever. The dog had a chill during the fore part of the operation in all probality due to effects of the ether.

A control was run on this series, following the technique described above, but without spinal manipulation.

In this control, we found that the variations were in accordance with the results obtained by the various research workers upon etherized animals, in that the amount of urine secreted was slightly decreased and that the amount of solids remained normal or slightly decreased.

Conclusions.

First. That the amount of solids secreted by the kidneys can be increased by osteopathic measures.

Second. That the specific center for kidney control is in the eleventh and twelfth segments of the cord.

This series will be continued extensively. We are using many animals for control, and in the final report, the pathology determining the specific spinal center for kidney control will be given.

EFFECTS OF SPONDYLOTHERAPIC PERCUSSIONS ON RESPIRATION AND BLOOD PRESSURE

SERIES No. 25.

O. M. WHITMORE, A. B., A. M.

The purpose of this series of experiments was to determine the effects of spondylotherapic percussion of the spines of lower cervical and dorsal vertebræ upon: 1st, Blood Pressure; 2nd, Respiration.

METHODS EMPLOYED.

Ten dogs were used in the experiments. The anesthetic, ether, was given by means of a tracheal cannula, in each instance being kept constant and deep. The respirations were recorded upon a tambour, attached to the tracheal cannula by a T-tube. The blood pressure was taken from the cartoid artery by the usual manometrical method. Normal tracings were made from all animals before the percussion tests were begun.

The method of percussion was that of an even stroke, about every one and one-half seconds, applied to the spinous processes of the vertebræ, with a small hammer, always light at first and gradually increasing to heavy. The periods of percussion varied from one and one-half to three minutes, with periods of from three to twelve minutes intervening between the series of percussions.

LITERATURE.

Very little literature can be found on this subject, since only Dr. Albert Abrams, (Leland Stanford, Jr. University), seems to have worked to any extent along this line. With reference to Blood-pressure, he states as follows, (Spondylotherapy, second edition):

"From what has preceded, one is justified in concluding that, hypertension is often a condition which is desirable and not to be opposed, insomuch as the vaso constriction may compensate a failing heart. In such instances,

vaso constrictors are injurious and the correct course to pursue is to strengthen the heart and the blood-pressure will fall of its own accord.

"The latter effect may be rapidly attained by concussion of the spinous process of the 7th cervical vertebra or more slowly by the administration of digitalis." (page 248).

Again he says, "one may rapidly reduce the blood-pressure by applying the percussar, large enough to include two spinous processes, of a vibratory apparatus yielding a forcible percussion stroke to the spines of the 2nd and 3rd dorsal vertebræ." (page 250).

"When the blood-pressure is diminished in arterio-sclerotics by aid of concussion, it is usual to find a heart showing little or no enfeeblement. If there is no fall of pressure following concussion of the 2nd and 3rd dorsal spines, and a fall is only observed after concussion of the 7th cervical spine, the high pressure is caused by cardiac weakness, and concussion of the spine in question is indicated to reduce pressure, which it does by toning the heart."

"If a patient has certain symptoms which one assumes are caused by the arterial hypertension, a reduction of the latter by the foregoing method, (concussion of the 2nd and 3rd dorsal spines or the 7th cervical spine), suggests the correctness of the diagnosis, and the treatment conducted along the same lines will prove in a relative sense, curable." (page 250).

"The author has established empirically that concussion of the spines of the 6th and 7th dorsal vertebræ will raise the blood-pressure. The results, however, are not as uniform as is the method for reducing blood-pressure, and not infrequently, the effects are only noted after a lapse of about two hours." (page 253).

Results.

Of the ten dogs used in these experiments, detailed reports will be given of five, the results obtained from the other five being similar to these. The animals used in these experiments showed normal blood-pressure and respiratory tracings to begin with, with the exception of Dog No. 1.

Dog No. 1. This dog showed a very noticeable lesion of the 2nd lumbar vertebra. Tracing No. 1 recorded an even but very low respiration, with the blood pressure fairly strong, though very erratic.

The lesion was then corrected and tracing No. 2 made. As a result of the correction, both the respiration and blood-pressure, to all appearances became normal, being stronger and even in each case.

After a period of 30 minutes, tracing No. 3 was made, which showed a continuation of the above strength and evenness.

The spondylotherapic percussion, showed a slight raise in respiration, with no change in the blood-pressure. Medium percussion to the same area, showed slightly more increase in respiration and a very slight change in blood-pressure. Heavy percussions in the same area showed a trace of an increase in respiration, while the blood-pressure showed no variation from that of the medium. Upon discontinuing the percussion, both respiration and blood-presure passed immediately to normal.

Dog No. 2. Normal tracings showed both respiration and blood-pressure to be strong and even. Light percussions applied to the 4th dorsal vertebra showed a very slight rise in blood pressure with a slightly stronger respiration. Medium percussion to the same region showed a very slight rise over the light percussion in blood-pressure, but no change in respiration. Heavy percussion in same regions showed no change in the blood-pressure nor in the respiration.

Both the respiration and blood-pressure returned to normal immediately upon discontinuing the percussions.

Dog No. 3. A normal tracing showed an even, full respiration and blood-pressure. Light, medium, and heavy percussions were applied to the 2nd to 4th dorsal vertebræ inclusive, with only a slight rise in respiration in each case, and no variation in blood-pressure. The increased respiration immediately returned to normal upon discontinuing the percussions.

Dog No. 4. Normal tracings showed both respiration and blood-pressure to be even and strong. Light, medium and strong percussion to 4th dorsal showed a very slight increase in each instance, in both respiration and blood-pressure. Upon discontinuing the percussions, the tracing immediately registered the normal.

Dog No. 5. Normal tracings showed both respiration and blood-pressure to be even and strong. Light percussions applied to the 6th and 7th dorsal vertebræ, resulted in a very slight increase in respiration, with no change in blood-pressure. Medium percussions to the same area produced a very slight increase in respiration and blood-presure. Heavy percussions produced only slight increase in

the respiration, with no increase of blood-pressure over that of the medium percussion.

Upon discontinuation of the percussion, the tracings immediately passed to normal.

Conclusion.

Owing to the very slight variation from the normal tracings, and the fact that immediately upon discontinuing the percussions, the tracings were again normal, we conclude that any variation which may have appeared were due to mechanical motion or disturbances rather than to any stimulatory effect from the percussion.

However, as we compile the above results, taken from operations, performed by others, it seems hardly just to state from these results, that the percussion method falls short of its claims. Because Dr. Abrams states in each instance that the results of his percussions come as a toning effect upon an abnormal condition of the heart and vessels. Whereas, in the above operations, the normal was used from which to derive the abnormal under treatment. Again, upon comparison of the technique of the above operations with those of Dr. Abrams, you will find some variations in time and in the areas to which the percussions were applied.

Observations of Results.

J. Deason.

In the case of Dog No. 1 it seems that the lumbar lesion may have had the same effect as described in Series No. 10, and that the correction brought about a normalization of the visceral reflexes.

The fact that some variation in blood pressure and respiration resulted from percussion is, I believe, nothing in favor of the specific idea of Abrams, because the above results show no constant results. Such variations may result from any sensory stimulation.

In my opinion the above results show nothing more than what has long been known about mechanical stimulation and that there is nothing specific or different in any of Abrams' claims.

AN EXPERIMENTAL STUDY OF FILARIASIS[1]

Series No. 26.

Report of the A. T. Still Research Institute.

Parasitology, Symptomatology and Treatment.

By J. Deason, M. S., D. O.

Twenty-four Rhesus monkeys were purchased from a local dealer October 1st. They were shipped from tropical South America and were taken by us as soon as they were received in Chicago. They seemed to be in good physical condition except that some of them were affected with diarrhea and were somewhat emaciated. This, however, is a common condition in monkeys as a result of poor care and improper feeding during transportation and therefore no specific disease was suspected.

These animals were kept in two large cages ten by twelve feet, one of which was outside where the animals could get plenty of fresh air and sunshine and the other was inside of the animal house where the animals would have a warm place to sleep and be protected from bad weather. The monkeys were free to go into either cage as they wished. These cages have cement floors and running water and drains to sewer. All monkeys were kept from one week to one month in these large cages before they were isolated.

Care of Animals.—When individual study was begun, the monkeys were removed to separate cages (one animal to each cage) which consisted of wire netting, twenty by thirty by forty inches. The floor consists of closely woven hardware cloth and is so arranged that it can be removed for cleaning. Beneath the floor a galvanized sheet-iron pan is suspended for collecting the urine which is drained into

1 The parasitology, symptomology and treatment has been studied by Dr. Deason; the urinary changes by Dr. Hollands; the blood changes by Dr. Nicholson and the Pathology of the disease by Dr. Collins.

a clean cup. This makes possible the collection of urine free from feces and other foreign material, for analysis and also makes it easy to keep the animal clean and sanitary.

These cages are used for the purpose of isolating animals for individual study before and after lesioning, but in this case, we found it necessary to use them for the study of sick monkeys.

All animals which seemed emaciated or otherwise abnormal were soon isolated that they might receive special diet and care. The isolation cages were kept in a large room, twenty-five by fifty feet with cement floor and good drainage. The room was well ventilated and evenly heated by steam pipes during cold weather. When the weather was sufficiently warm the isolation cages were carried into the open air and sun light. The floor of the animal room was washed daily to maintain good hygienic conditions. Any experimental work which is done on animals counts for very little unless the environmental conditions, such as good sanitation, proper feeding, proper room temperature, etc. are constantly maintained. Monkeys, more than any other animals, must have plenty of fresh air but must not be exposed to drafts.

Feeding of Animals.—All monkeys, except those showing symptoms of disease, were fed at regular intervals five times daily as follows: At 7 A. M. well toasted bread; at 10 A. M. grain consisting of corn, wheat, sun-flower seed, etc.; 1 P. M. well boiled rice (sometimes the rice was mixed with toast and milk); at 3 P. M. some kind of vegetables or fruit such as carrots, turnips, cabbage, apples, or bananas, but always in small amounts as too much fruit or vegetables is often causative of diarrhoea. At 6 P. M. boiled rice was again given.

This may seem to be frequent feeding, but our experience and careful study of this problem leads us to believe that this is best. When it is known that the monkey's stomach is empty in from thirty to forty-five minutes after eating a full meal, the need of frequent feeding will be seen.

The above diet is not followed exactly, but nearly so. Frequent changes of diet seems to be most satisfactory, therefore the varied list as given above.

The Disease Filariasis.

The study of the disease, filariasis, came more as an unwelcome necessity than as a prearranged plan of work. For the study of infectious diseases in animals, however, we much prefer to use animals which have contracted some disease (to which they are normally susceptible) in a natural way, than to study the effect of diseases resulting from artificial inoculation.

Soon after the monkeys had been received it was found that several of them were suffering from what seemed to be a chronic diarrhoea. Careful dieting was tried with little benefit. The animals so affected continued constantly to lose weight and were drowsy and weak. Dr. Hollands, while examining a sample of urine first found the parasite which we later found to be the cause of the disease. All of the affected animals were removed from the large cages to isolation cages as soon as symtoms of the disease appeared and every precaution was observed to prevent the spread of infection.

Parasitology.—It will be possible to give only a brief summary of the nature of these parasites and those who wish to make a further study of the subject are referred to references given.

Many attempts were made to culture these organisms on several different kinds of artificial media, but we have never succeeded in doing so. The parasites have been kept alive in rabbit serum for two or three days, but so far as we could determine there was no multiplication or growth. Guinea pigs and rabbits were inoculated with the blood of affected animals. One rabbit died from the infection and the parasites were found in its blood on post-mortem, but the guinea pigs seemed to be unaffected. Guinea pigs have a marked resistance to certain animal parasites, notably Trypanosomes. (Lavaran and Mesnil.)

The disease filariasis (sometimes improperly called sleeping sickness)[2] is common to many different animals, man included. The causative factor is a metazoon parasite of which there are a great number of varieties. The parasite of this group with which most physicians are familiar by name, is the filaria sanguinis hominis of Lewis (more properly termed microfilaria bancrofti) (Manson) but later study has shown that there are many other filaria that affect the human.

The organisms are found in the blood and other body fluids in great numbers in affected animals. Those found in the body fluids are considered to be the embyros (microfilaria) resulting from eggs which are produced by a pair of adults which reside somewhere in the body. The adult organisms which have in some species been demonstrated, "are long hair-like, transparent nematodes, three or four inches in length. The sexes lie together often inextricably coiled up, several in a bunch and tightly packed, in a little cyst-like dilatation of the distal lympathics". Manson. Maitland.[3]

The microfilaries are transmitted by mosquitos similar to malaria. A number of different kinds have been shown to carry the parasite, but one Culex fatigans that affects mankind.

The microfilaria that we have found in our affected monkeys does not correspond exactly to any of the described forms, but we do not claim to have discovered an unknown variety. They are all microscopic, transparent, snake-like organisms which can readily be seen at a magnification of 300 diameters. They vary in length from 150 to 350 micra and are from 5 to 8 micra in thickness. They are sometimes found enclosed in a thin transparent sheath. They stain with most blood stains but may be seen in unstained blood smears.

When they are contained within the sheath, staining is more difficult. In fresh smears and in hanging-drop

2 The term "sleeping sickness" is more properly applied to trypanosomiasis, but the two diseases have many symptoms in common such as the stupor, loss in weight, etc.

3 We have found none of the parent forms in our affected monkeys but have searched for them at every post-mortem.

preparations of freshly collected urine or blood snake-like motility can readily be seen. We have found motile microfilaria in the blood, lymph, cerebrospinal fluid, nasal discharges, urine and fecal discharges of our affected monkeys. The parent forms are probably oviparous, the young being born as free swimming microfilaria. In some instances the ova are passed directly into the lymph stream. Twice we have found these ova in our affected animals.

Symptoms[4] We believe these monkeys were all infected when they were received. The symptoms as we have found them are diarrhoea, which is followed by marked loss of weight and stupor. The animals sit crouched over as if asleep. The hair is ruffed and as the disease progresses it falls out. They become disinterested in their environment and refuse food. The temperature (taken per rectum) varies from subnormal to as much as 104 degrees F. Oedema of the face and neck has occurred in several of our animals, but we have seen no signs of elephantiasis or ulceration. The urinary changes, blood changes and pathology will be given later.

Methods of Treatment. Much has been said and written concerning the methods of treatment in filariasis but we will not be allowed the space to give a description of the various methods here. In order to determine the relative value of the two systems, osteopathic and medical, our animals were divided into two groups, the one being treated by recognized medical methods while the other was treated according to the osteopathic theory. All animals were kept under exactly the same environmental conditions and were fed in the same way. No difference was made in the selection of animals but they were taken in their turn as the symptoms appeared, one being placed in one series and the next in the other. No discrimination was made as regards the progress or the disease in placing the animals in one series or the other.

Theories of treatment. Much experimental work has been done on humans and animals, but medical authorities claim little in the way of reliable treatment for the disease

4 The symptoms of this disease were described by Abubter Mohamed Rhais, 850 A. D.

or its resulting symptoms. We quote the following from some of the standard works on practice.

"There is no known means of destroying either the mature worm or the embryos within the human body, and unfortunately, the death of the parasite may not be followed by relief of the obstruction." French's Practice of Medicine, Williamson, 4th edition.

"So far as I know, no drug destroys the embryos in the blood." Osler, 8th edition.

"Healthy subjects must protect themselves against mosquito bites. Filtering, boiling, and storing the drinking water in mosquito-proof receptacles are important measures. Thymol, in from 1 to 5 grain (0.0648-0.324) doses, given for from two to eight weeks has caused the disappearance of larval filariæ in several cases. Methylene blue appears also to have produced a cure in a case of chyluria reported by Flint. Henry, however, states that he had given this drug in larger doses than were used in the case reported by Flint, and for a much longer period without the slightest effect upon the parasites. The adult filaria seems to be beyond reach of any known medication that will not prove dangerous." Anders, 3rd edition.

Referring to the treatment of this disease Edwards states that "no parasiticide is known." Edwards, 2nd edition.

Referring to the drug treatment of this disease Manson states as follows:

"I do not believe that these substances have any influence whatever in stopping the lymphorragia. Neither do I believe that thymol recommended by Lawrie or methylene blue, recommended by American writers, has any effect either on the filaria or on the disease it gives rise to; since the first recommendation both drugs have been tried but in other hands have failed." Tropical Disease, 4th edition.

Quoting from Harston's Care and Treatment of European Children in the tropics. "This, the medical treatment is very unsatisfactory. There is no drug which has any effect on the adult filaria or the embryos."

Quoting from Jackson's text book on Tropical Medicine: "The drug treatment for the disease is unsatisfactory."

It has been shown (Lavaran and Mesnil) that phagocytes may actually ingest living parasites (trypanosomæ) if the animal is in a healthy condition at the time of the inoculation. Why cannot the same be expected of affected animals if they are put in normal condition? We believe

that the factors influencing curative effects in our animals have come as a result of the normalization of the animal, the maintenance of proper blood supply to the involved structures, the regulation of the functions of the hæmatopoietic structures, the regulation of the functions of the organs of metabolism and elimination by osteopathic treatment and the careful feeding and general care of the animals.

Concerning the mechanism of resistance and the theories of chemo-therapy in parasitic disease we would refer the reader to the following authorities: Infection and Immunity, Simon, 1913 edition; Immunity in Infective Disease, Metchnikoff; Studies in Immunity, Bordet-Gay.

Case Reports.

Monkey No. 13. When isolated this animal weighed 2460 grams. It had a slight diarrhoea and a ravenous appetite but no other symptoms. After two weeks the diarrhoea increased and it began to show signs of stupor and emaciation. The weight had decreased during this time to 2090 grams. Filaria parasites were demonstrated in the blood and feces. Upon careful examination lesions of the mid and lower dorsal regions, principally rigidity, were found and corrected by treatment. Some improvements were observed from the treatment, but the diarrhoea, emaciation and stupor began to increase after a few days and the animal died at the end of the third week, October 21st.[5]

Several mistakes in treatment were made, we think, as follows: first, the treatment was not begun until after the animal was greatly emaciated and very weak. Second, the treatment was probably too severe; third, the diet was not as well regulated as it should have been (all other animals after the cause of disease was known were fed on Pasteurized milk, well toasted bread, and thoroughly boiled rice;) fourth, another unfavorable factor was that the cages were at first washed daily without removing the animals (monkeys 13 and 14 were the first treated) others were removed to dry cages thus avoiding the chilling that might have resulted from the wet cages.

Monkey No. 14. This animal had diarrhoea when received which gradually increased. It seemed drowsy and weak, but ate well. After the first week the diarrhoea increased and it refused food. The lower gut was washed

5 The results of post-mortem findings will be given later.

twice with warm normal salt solution and lesions of the third and fifth dorsals (rotation with rigidity) were corrected. Warm milk and toast soaked with milk given. After a few days the animal refused to eat. Later it was given browned flour mixed with cream, one ounce, by stomach tube and one ounce per rectum, twice daily. This feeding was continued for five days during which time the animal seemed to be much improved. The feces were less watery, contained less mucus and the monkey seemed much stronger. It drank large quantities of water and milk. At the end of the second week the animal was given by mouth 0.4 gram of magnesium sulphate at 2 P. M. which was followed by 0.1 gram of thymol[6] at 7:30 P. M. The animal was found dead the following morning. This treatment was given for the purpose of removing the parasites from the intestines. Filaria were found constantly present in the blood and stools while under observation. It lost in weight from 2221 to 1855 grams in two weeks.

Monkey No. 15. This animal had diarrhoea and poor appetite when received. Upon examination, lesions of the first and second lumbar vertebrae (rigidity) were found and were corrected and it was given gentle treatment every two days for the purpose of maintaining correction. It was also given a warm normal saline enema twice when the treatment was begun. The osteopathic treatment was continued for one month (October) during which time the animal was much improved and had gained in weight from 2,325 to 2,500 grams. It had an occasional cough and parasites were constantly present in the blood and stools, but the appetite was good and the stools were normal after three weeks of treatment when the treatment was discontinued. During the second week in November it had a second attack, with symptoms as before. There was diarrhoea, a loss of one hundred grams in weight, weakness, stupor, and loss of appetite. Examination of the blood showed red corpuscles 3,556,000; white corpuscles 14,100 with an excess of eosinophiles. The parasites in the blood stream were also increased. One slide contained seventy-three parasites.[7]

Osteopathic treatment was again given, also two enemas of warm normal salt solution. The animal was fed pasteurized milk, one ounce by stomach tube and one ounce

6 Cushny, Pharmacology and Therapeutics 1913 ed. gives the dose of thymol as an anthelmintic as 2 grams (30 grains) to be repeated in two hours. The proportionate dose for monkeys weighing from 1 to 2 kilograms would be from 70 to 100 milligrams. In no case was the allimentary tract found free from parasites after this treatment.

7 The blood changes will be given more fully later.

per rectum, twice daily for three days. The stools became solid and the mucus disappeared as before. The appetite slowly returned. During the rest of the month (November) there was some, but no marked improvement. On December 2nd, a blood examination showed red corpuscles 4,560,000 and white corpuscles 10,800 and a marked decrease in eosinophiles. The general condition was much improved; the appetite was good, there was no diarrhoea, but the weight had not increased. During the second week of December the monkey had a second relapse with symptoms as before except that they were not so marked. Osteopathic treatment was again begun but enemas were not used. The treatment was followed by general improvement. The animal seemed to have a better appetite and less stupor but the weight did not increase. It now weighed 2,034 grams. From this time on to March 20 it seemed to remain about the same. Sometimes for a week or more it seemed to be much improved but we were not able to improve the nutrition and parasites were constantly present in the blood. About March 20th it seemed to be pneumonic. There was edema of the face, it became weak, refused food and died April 2nd. The results of post-mortem examination showed the probable cause of death to be pneumonia and tuberculosis.

Monkey No. 16. This animal seemed in good condition except that it had diarrhoea. It was isolated October 17th. During the remainder of the month it had no symptoms other than a slight diarrhoea. Its appetite was good and it showed no signs of stupor. On November 2nd it was found that its weight had decreased from 2,010 to 1,895 grams and examination of the blood revealed the presence of parasites. It had a rigid condition of the mid-dorsal region fifth to the eighth which was corrected in three treatments. The appetite gradually increased and the stools became normal after the treatment. On November 11th its weight had increased to 1,950 grams. During the remainder of the month, it continued to improve and on November 27th, a blood examination showed red corpuscles 4,996,000; white corpuscles 10,400 and no eosinophiles. This animal continued to increase for another month and was then turned over to Drs. Hollands and Nicholson as normal, to be used on another series. A complete recovery from the original disease was effected in this case. The monkey is still in perfect condition.

Monkey No. 17. This monkey was seemingly in good physical condition except that it had a slight diarrhoea when first isolated, October 17th. It was treated for a few days

for the purpose of correcting a rigid mid-dorsal condition. It remained in perfect condition and constant weight of 2,360 grams until October 20th when a severe diarrhoea developed. Treatment was again begun and after a few days it seemed in good condition and the stools were again solid. During the rest of the month it remained normal. Examination of the blood of this animal during the following month, December, showed a few sheaths of parasites but no living parasites. It was therefore normalized for another series of experiments. It has been normal and in perfect condition for more than five months and has shown no symptoms of the original disease.

Monkey No. 18. This animal was placed in an isolation cage October 17th. It seemed to be in a fair condition except a slight diarrhoea. A rigid lower dorsal and upper lumbar region was treated and corrected within a few days after it was isolated. From the time it was received until November 1st, it continued to lose in weight, but its appetite was good, its general condition was good and there was only an occasional diarrhoea. Parasites were found present in the stools and blood of this animal almost constantly during the first two months of observation. During these two months, the animal lost in weight from 2,975 to 2,728 grams, and it seemed somewhat emaciated. Albumin was almost constantly present in the urine during November. From this time it continued to gain in weight and remained in perfect condition. It was therefore normalized for another series. No parasites were found in the blood after November 22nd. This animal is at present time, Mar. 1916, in perfect condition and has grown much larger and stronger.

Monkey No. 19. When received this animal was greatly emaciated, and had a very poor appetite. The stools were soft and examination showed parasites to be present in the blood and stools. It was isolated October 15th and was treated osteopathically for the correction of a rigid condition of the eighth, ninth and tenth dorsal vertebrae. Its condition improved and during the month it gained in weight from 1,445 to 1,530 grams. Treatment was discontinued and during November it continued to increase in weight to 1,580 grams. A blood examination on November 19th showed red corpuscles 6,436,000; white corpuscles 5,200. There was no increase in the eosinophiles and no parasites. This animal continued to improve and on January 27th its weight had increased to 1,701 grams. It had made a complete recovery and was used on another series.

Monkey No. 20. This animal seemed in good condition with the exception of a slight emaciation and a slight diarrhoea. A few parasites were found in the blood and stools but the animal was never in a bad condition. During the first month it lost in weight from 2,130 to 2,040 grams.

Treatment was begun, November 2nd, for the purpose of correcting a rigid mid-dorsal condition. On November 10th, the animal had increased in weight to 2,125 grams, the stools were solid and the animal seemed normal in every way. A blood count showed red corpuscles 4,552,000 and white corpuscles 12,900. There was no increase in eosinophiles and only a very few parasites were found. This animal continued to improve and had remained in perfect condition to this date, April 20th. Parasites are no longer present and the animal is being used on another series.

Monkey No. 21. This monkey like the others was in fair condition with the exception of soft stools. During the first two weeks it lost in weight from 2,360 to 2,075 grams. Parasites were demonstrated in the blood and stools and the diarrhoea had increased. A rigid condition of the lower dorsal and upper lumbar region was found but the animal was not treated. On November 24th it was given 0.4 grams of magnesium sulphate which was followed by one-tenth gram of thymol a few hours later. The next day the animal seemed weaker and was given two cubic centimeters of alcohol in thirty cubic centimeters of milk the following evening. The next morning the animal was found dead.

Monkey No. 22. This monkey presents about the same clinical picture as number twenty-one. The feces were soft but there was no marked diarrhoea and no emaciation. It had a rigid mid-dorsal region but this was left untreated. Its appetite was good during the first two weeks, but after this it began to eat less and seemed inactive. Its weight had decreased from 2,060 to 1,970 grams. There were signs of stupor and parasites were present in the blood and stools. It was given one ounce of pasteurized milk by stomach tube and one ounce per rectum twice daily for three days. The magnesium sulphate and thymol treatment was given as above on October 24th. The animal died about noon on the following day.

Monkey No. 23. This was the only monkey of the twenty-four that showed no symptoms of the disease and in which filaria have never been found. It has remained in perfect condition with no symptoms of any kind.

Monkey No. 24. This animal had a bad diarrhoea when it was first isolated, November 17th. It was weak and emaciated and its appetite was poor. Dr. Frank Smith examined this animal, found a lesion of the second lumbar and also a right innominate lesion which he corrected. It was given a warm normal salt enema at the same time and the diarrhoea was much improved. During the following two days there was some improvement but the animal never regained its strength or appetite. It died October 22nd. We believe that treatment in this was begun too late to be of any great value. Parasites were found present in the blood and intestinal tract in post-mortem examination.

Monkey No. 25. This animal seemed in fair condition with the exception of soft stools when it was isolated, October 15th. It was examined by Dr. Frank Smith who found a rigid lower dorsal and upper lumbar. It was treated once, but the treatment was not continued. It was given a warm normal salt enema following which the stools were more solid. On October 23rd there was a marked diarrhoea and the appetite was poor. A blood count showed red corpuscles 7,880,000; white corpuscles 6,720, and parasites were found present in the blood and stools. The emaciation continued and the animal showed signs of stupor. It was given two c. c. of alcohol in 30 c. c. of milk once daily for the following three days. The alcohol was discontinued and ten drops of urotropin were given twice daily with 30 c. c. of milk for the following two days. It did not seem to improve and on October 28th it was given 20 milligrams of sodium cacodylate hypodermically. The animal died October 30th. Motile parasites were found in the intestinal tact, blood, cerebrospinal fluid and nasal discharges upon post-mortem examination.

Monkey No. 26. This animal was isolated October 15th. Its appetite was fair and stools were normal and it seemed in good condition. On October 17th it developed a diarrhoea and showed signs of stupor. It was treated for a few days for the purpose of correcting a rigid mid-dorsal condition. During the following four weeks its general condition improved, the stools became solid and it gained in weight from 1,765 to 1,860 grams. This animal was considered normal although the parasites had not entirely disappeared from the blood. It was changed to another series and after normalization it was lesioned November 12th (rotation between 11th and 12th dorsals.) At this time a blood count showed red corpuscles 5,265,000 and white corpuscles 4,300. There were no eosinophiles, and only a few parasites present. Albumin was found present in the

urine, November 30th. Dr. McConnell exaggerated the lesion which had been produced. The albuminaria increased and the animal died December 2nd. (See report of post-mortem examination.)

Monkeys No. 27, 28 and 29. These animals died after we had had them only a few days. The cause of death was unknown but because they had symptoms similar to the others we believe they had filariasis.

Monkey No. 30. This animal showed symptoms of filariasis as described above, namely, emaciation, stupor, diarrhoea and decreased appetite. Lesions, subluxations and rigidity of the second, third and fourth lumbars were corrected, but this treatment was not continued. The animal was given plenty of warm milk and toast soaked in milk and seemed to improve during the rest of the month. On November 1st the symptoms of filariasis reappeared. It was given thirty milligrams of sodium cacodylate hypodermically which was followed the next day by fifteen milligrams of sodium cacodylate. There seemed to be no improvement and the animal died three days later. Parasites were demonstrated to be present in the body fluids.

Monkey No. 31. This animal was isolated October 26th. It seemed normal with the exception of slight diarrhoea. An examination of the blood showed the corpuscles to be normal. Reds, 5,000,000 and whites 7,800. There were no eosinophiles, but a few motile parasites were present. The symptoms became more marked during the following month, and it lost in weight from 2,300 to 2,000 grams. On November 27th blood examination showed reds 6,000,000 and whites 21,800, and a marked increase in parasites. It was given a normal salt enema and rigidities of the mid and lower dorsal region of the spine were treated regularly osteopathically. At this time the average daily temperature was 103.8 F. From this time on there was a constant improvement and the weight had increased to 2,260 grams, by December 27th. There was no more stupor and the stools were solid. During the month of January the animal increased in weight to 2,332 grams. At this time no parasites were found in the blood. About this time this monkey was exposed to cold accidentally and it has since (during the past two months) been showing signs of pneumonia and tuberculosis, but at present is improving.

Monkey No. 32. This animal was received October 14th, but was not isolated until October 26th. During this time it had shown some symptoms of filaria but they were not marked. On November 18th the symptoms as described above, namely, diarrhoea, stupor and emaciation were devel-

oped. Parasites were found in the blood, reds were 3,908,000 and whites 21,400 with a few eosinophiles. The weight had decreased from 2,400 to 2,300 grams. A rigid mid-dorsal region was treated osteopathically and by December 1st, the animal seemed to be again in normal condition. The weight had increased to 2,375 grams and the stupor and diarrhoea had disappeared. Parasites, however, were still present in the blood but not in such large quantities. On December 20th, this animal was exposed to cold and developed pneumonia. It gradually grew worse and died January 1st. During this time it had lost in weight to 2,339 grams. A post-mortem examination showed the animal to be tubercular which we believe to have been in association with the pneumonia, the direct cause of death.

Monkey No. 33. Isolated November 2nd. It gradually developed symptoms of the disease similar to those described above. The mid and lower dorsal regions of the spine were rigid. It was given 15 milligrams of sodium cacodylate hypodermically on November 11th. It was also fed on warm Pasteurized milk. There was no improvement and it died November 15th.

Monkey No. 34. This animal was isolated November 2nd. Its weight was 2,345 grams and it showed no symptoms of filariasis. No specific lesions or rigidities of the spine were found. On November 22nd it developed symptoms of filariasis as described above, such as emaciation and drowsiness but there was only a slight diarrhoea. It had lost in weight to 2,270 grams. A blood examination showed red corpuscles 5,468,000, and white corpuscles 33,600 and motile parasites. At this time a rigid area of the mid-dorsal region was found and treatment for its correction was begun. The animal continued to lose in weight during the following two months but the sypmtoms of filariasis disappeared and the blood picture was materially improved. This animal has continued to improve and at the present time it is in perfect condition.

Monkey No. 35. This animal was isolated November 22nd. It weighed 1,860 grams. The lower dorsal region of the spine was found to be rigid and treatment was continued for two weeks. During the month of October this animal had constantly showed filaria to be present. During the month of November the animal improved in every respect. Its weight increased to 1,910 grams; its blood count became normal and no more filaria were found. It was therefore changed to another series and has remained in perfect condition to the present date.

Monkey No. 36. This animal was received October 14th and kept in the large cage until November 2nd. It had shown no signs of filariasis during this time except an occasional slight diarrhoea. It was isolated November 2nd, and during the following two weeks the symptoms became more marked. It had lost from 1,580 to 1,490 grams and showed signs of weakness and stupor. It was given two warm normal salt enemas and was given milk, one ounce by stomach tube and one ounce per rectum twice daily. During the following two days the animal greatly improved and drank milk and ate toast as other animals did. A rigid area was found in the mid-dorsal region but this animal was not treated osteopathically. On November 13th, it was given 50 milligrams of neosalvarsan in 6 c. c. of sterile water. The injection was made intramuscularly and was used as soon as opened. Six hours later the animal was found dead.

Summary of Results.

Of the fourteen animals treated osteopathically thirteen showed improvement after treatment and seven made complete recoveries.

In the cases of three of those that died, death was probably due to complications of pneumonia or tuberculosis or both. One died after being lesioned, and in the others drugs were used following or in conjunction with the osteopathic treatment.

In seven monkeys treated by drug therapy there were no recoveries, and no improvement other than very temporary improvement in two cases, which should, we believe, be attributed to the good care and proper feeding.

Conclusions.

From the results of this work we believe we can safely conclude:

1. That resistance to infection can be increased by osteopathic treatment.

2. That physiological perversions of function such as impaired nutrition, can be normalized by the correction of such lesions and aids in the treatment of the disease.

4. On post-mortem examination after administration of certain so-called parasiticides living parasites were found in the body fluids and ailimentary tract. Therefore,

we believe that these drugs have little or no effect as humeral or ailimentary antiseptics.

The result of this work does not by any means show that there is no value in drug treatment of filariasis because many more animals should be used, and more careful study should be made to determine this. Neither does it show that we can successfully treat all cases of this disease by osteopathic methods; but it does show that osteopathic therapy combined with proper feeding and good sanitation is effective in the treatment of this disease.

References.

Tropical Disease, Manson, 4th edition.
Laboratory Studies in Tropical Medicine, Daniels, 3rd edition.
Tropical Medicine and Hygiene, Daniels and Alcock, Part II.
General Bacteriology, Jordan, 3rd edition.
Pathogenic Bacteria and Protozoa, Park—Williams.
Manson's Lectures 1905, published in book form.
Tropical Medicine and Hygiene, Daniels.
Tropical Medicine, Jackson.
French's Practice of Medicine, 4th edition.
Osler's Practice of Medicine, 8th edition.
Anders' Practice of Medicine, 3rd edition.
Edwards' Practice of Medicine, 2nd edition.
Hartman's Care and Treatment of European Children in the Tropics.

A good review of many of the principal papers on this subject may be found in the Bound Volumes. "Bulletin of Tropical Diseases", System of Clinical Medicine, Savill.

The various systems of Practice and cyclopedia of medicine also gives discussions on this subject.

Diseases of the Dog, Muller—Glass.
Practical Sanitation, Gardner and Simonds, 1914 edition.

For methods of laboratory study we recommend references, 1, 2, 3, 4, 5, 6, 7, 8, given above and Diagnostics of Internal Medicine, Butler, 3rd edition.

Diagnostics Methods, Webster, 1913 edition.
Sahli's Diagnostic Methods, Potter, 1911 edition.
Clinical Diagnosis, Emerson, 1913 edition.
Clinical Diagnosis, Simon, 1911 edition.
Clinical Pathology of the Blood, Erving.

PATHOLOGY FOUND IN THE EXPERIMENTAL STUDY OF FILARIASIS

By H. L. Collins, D. O.

Not much work has been done relative to the pathological changes produced in the various tissues by the filaria parasite. Most workers seemingly have centered all their efforts on the study of the life history of the parasite and the sites where it may be found in the body. Therefore we have not much material with which to check the greater part of our results, obtained in the pathological studies of this condition.

According to Man in his work on tropical disease the lymphatic system is one of the chief tissues of the body involved. He also mentions that the filaria can generally be found in the blood of the lung when they are absent from the peripheal circulation. Daniels in his work on Tropical Medicine says that often the only evidence of the filaria in the lymphatic is that there is a lymphatic obstruction causing an enlargement of the lymphatic structure. He also states that the filaria are to be found in the pelvis of the kidney and in the lymph glands. There are various other authors who have works on this subject but they are practically all the same, so we will not go into a lengthy discussion of the various exceptions and findings which they put forth, aside from what we have already mentioned. There are several references at the end of Dr. Deason's article which one may refer to if they want more detailed information. We will give a brief summary of our pathological findings, both macroscopic and microscopic.

Briefly the macroscopical findings are as follows: The animals were all very emaciated and had lost considerable weight. In some cases there was considerable oedema about the face and the extremities. The superficial lymphatic glands were enlarged. The internal examination showed the stomach and small and large intestines anemic and very much distended with gas. The lymph glands were

the most involved. An excessive amount of fluid was found in the abdominal cavity. The liver, a little large, the heart was dilated in most instances, and the lungs were collapsed except in one or two instances, where a secondary condition had been grafted upon the already present disease. For instance, in Monkey No. 32 there were tubercular foci in both lungs.

Microscopical examination revealed the following conditions:

1. The Liver. Very much congestion and in some cases areas of fatty degeneration were found.

2. The Kidney. Very much congestion. In Monkey No. 26 there was a well-defined albuminous degeneration. This animal had been lesioned between the 11th and 12th dorsal segments of the spine which might account for the increased pathology found.

3. The Lung. Was congested but the amount of congestion varied in different animals. It was however, always present to a greater or less degree. In Monkey No. 32 tubercular foci were found in both lungs.

4. Large Intestines. Parenchymatous degeneration of the mucosa.

5. Small Intestines. Parenchymatous degeneration of the mucosa, but not as severe as in the large intestines.

6. Spleen and Pancreas. Both congested.

7. Adrenals. Congested.

URINALYSES OF FILARIASIS

A. Hollands, D. O.

Very little has been done in the study of the changes in urine regarding the disease filariasis. Most authors have confined themselves chiefly to the description of the parasites and their mode of transmission.

Nearly all authors are agreed that chyluria or hematochyluria are possible findings, but only when there is a rupture of some lymph vessel; others state that the urine in filariasis may be normal for long periods of time. Others, that the embryos may be found in the urine at any time during the day or night. In our series the parasite was first found in the urine.

It is stated that the retention of urine is a common symptom, later giving way to the passing of wort-like clots. Castellani and Chalmers say that albumin is a constant finding.

In our examination we were greatly handicapped in that we were able to collect only a few c. c. of urine at any one time. This prevented our making the tests for specific gravity, quantitive albumin, sugar, blood, casts, etc. In a few instances the urine appeared to be absolutely normal; in some casts were found, but in the majority albumin was a constant finding. In one of our animals blood was present in two different analyses but was negative after that. The analyses for sugar were always negative.

In several instances the embryos were found. In a few examinations the parasites were slightly motile, in others they were very active.

In no specimen did we find chyluria.

The Hematology.

By F. M. Nicholson, D. O.

As is stated in the general report on filariasis, the condition prevalent among the monkeys was an unlooked-for opportunity for the study of the malady from the stand-

point of natural acquisition rather than from that of artificial production, and the results that could be obtained by means of therapeutics.

Believing at first that the slight diarrhoea was due to the variation in diet, too much exercise, and new environment, accompanied by the loss of weight, which would of course be expected in diarrhoea, we paid little heed to the first few and seemingly insignificant symptoms, and were thus confronted with laboratories unequipped for the study when the disease made its onset,—partly due to the fact that all the necessary instruments and apparatus were not yet at hand and partly, that the necessary stains had not been prepared for such an unexpected finding.

However, when the parasite was discovered by Dr. Hollands (which was done in the course of a few days) all was in readiness for laboratory diagnosis, but unfortunately, the illness of some of the monkeys increased so rapidly that they died before we were able to determine any changes in the blood stream and what results therapeutical measures produced.

The infection filariasis, in relation to its hematology, is not entirely definite as in regard to its effects upon the hematopoetic tissues and the changes which take place in the blood and the effect upon the percentages of the different cells in the blood.

It is, of course, expected that there should be a blood change when filariasis is known to be a parasitic infection in which the embryos are found in the blood stream, and when their parental origin is in the deeper lymphatics.

The hematological characteristics in filariasis are,—anemia, a slight decrease in the percentage of hemoglobin, hyperleucocytosis, and the presence of the embryos varying from a scanty number in the daytime to a marked increase during the early part of the night. According to most authorities, the embryos remain in the larger arteries and in the lungs during the day and become most numerous in the peripheral circulation between the hours of five and nine P. M.

All of our examinations of the blood were made after three o'clock, between that time and six o'clock.

Therefore, the examinations were always made when the variation of the blood from its normal was either at its highest or on its approach thereto.

Leucocytes. The condition in the blood began with an increase in leucocytes (which is an essential factor according to Simon) rising from the normal (which is about the same as that in the human, 6,000 to 10,000) to 24,000. Calvert found the leucocytes in one case to be 26,666. In one of our animals the leucocytes were as high as 35,000 at one time, and in another animal, 34,100. A relation between the number of embryos and the percentage of the different leucocytes does not exist. (Calvert) Comparing Dr. Deason's enumeration of the embryos with the different cell percentages of leucocytes corroborates the above statement.

Lymphocytes. A lymphocytosis was always present. The variations we found were from normal (about 20%) to 46%, remaining more or less constant as the disease became chronic. One animal showed a lymphocytosis of 51%. Simon found in one case of long standing a 36% lymphocytosis.

Eosinophiles. In all our examinations the percentages of eosinophiles were normal (about 1% to 5%). Very little is known regarding the eosinophiles in filariasis. Simon says that an eosinophilea early in the disease is an essential factor. Calvert claims that an eosinophilea may be looked for, but that it diminishes as the infection becomes chronic. In one case he found an eosinophilea of 20%, in another 22%. In one case of long standing, Simon found the eosinophiles to be normal. Castellani and Chalmers write that the eosinophiles are sometimes increased. Calvert says that in one case the eosinophiles varied from 22% down to 8% in twenty-four hours. According to Adami the increase and decrease in eosinophiles is coincident with the appearance and disappearance of the filaria in the superficial capillaries. No doubt the reason for our not finding an eosinophilea is because none of our animals were examined at the time of the onset of the disease.

Other Leucocytic Changes. The other leucocytic elements were found normal with the exception of one

examination in which there was a 9% of vacuolization of lymphocytes. This monkey died after the blood count showed a leucocytosis of 21,400 and erythrocytes to be 3,908,000.

Anemia. Those of our animals that were first sick and had the most marked diarrhoea showed a marked anemia. The erythrocyte count varied from normal down to 2,608,000. Those monkeys that received their treatment regularly, lived. Those that did not, died. The one with the above anemia is now alive. Anemia of greater or less degree is a common symptom. (Simon) In the more marked cases we always found in the erythrocyte count, a few normoblasts, a microcytosis, and a poikilocytosis.

Manner of Catching Monkeys. To catch the monkeys, a pair of gloves were worn to prevent the possible results of their biting. Then a small box which was dark inside, was positioned by the open door of the cage. The monkey, seeing the dark hole, ran into the box. We did this in order that we might do away with the unnecessary handling. The catching was easy. They were caught by the back of the neck and taken to the laboratory. Here the ear was washed with soap and water, dried, rendered aseptic by the use of alcohol followed by ether, allowed to dry, and then puncture was made to obtain the blood specimen. When this was done, celloidin was applied to prevent infection. In no case did an infection occur.

Individual Findings.

Monkey No. 1. Died before anything could be determined.

Monkey No. 2. Died before anything could be determined.

Monkey No. 3. First examination showed erythrocytes as 3,576,000 and the leycocytes as 14,120, a slight poikilocytosis, but the other elements were of normal percentage. After the first month of treatment the erythrocytes were increased to 4,560,000 and the leucocytes decreased to 10,800. The second attack showed the erythrocytes as 3,152,000 and leucocytes as 21,500. After one month of treatment the white cells remained as 21,600, and the lymphocytes increased to 32%. As given in Dr. Deason's report, the blood picture remained in correspondence with

the general health of the monkey until March 20th. Treatment was given to it all the time. The leucocytes returned to normal, but the erythrocytes decreased to 2,408,000 a few days before its death. The normoblasts were 8% and accompanied by many microcytes, macrocytes, and poikilocytes.

Monkey No. 4. This monkey was not examined when it had its first diarrhoea. When examined Nov. 21 the erythrocytes were 4,996,000 and the leucocytes 10,400. After one month of treatment the erythrocytes increased to 5,640,000 but the leucocytes were a little less than before, being 10,300. In a short time the monkey was perfectly normal.

Monkey No. 5. This monkey showed at first the erythrocytes to be 4,312,000 and the leucocytes as 5,400. It was given good care and general treatment whenever it showed any signs of sickness. It became normal.

Monkey No. 6. When first examined, the erythrocytes were 5,728,000, and the leucocytes 9,000 with the lymphocytes at 27%. After treatment for three weeks the red cells were 5,232,000 and the whites, 6,300. The animal is now well and on another series.

Monkey No. 7. This monkey was in poor health for some time. The first blood count showed the erythrocytes 6,436,000 and the leucocytes 5,200. After treatment the count was, for red cells 5,328,000 and for white cells 6,800. The animal became normal and was put on another series.

Monkey No. 8. When this monkey first became sick the blood count was for the erythrocytes, 4,552,000 and the leucocytes, 12,900. Treatment was instituted and the next count was red cells 5,664,000 and the white cells 8,800. This animal also became normal and was put on another series. The last count showed the erythrocytes to be 4,060,000 and the leucocytes 4,900.

Monkey No. 9. Died before anything could be determined.

Monkey No. 10. Also died before any samples were taken.

Monkey No. 11. This monkey was always in good condition. The different blood countings always showed the red cells to vary between 5,836,000 and 6,052,000 and the white cells, between 8,100 and 8,200. At one time the lymphocytes were increased.

Monkey No. 12. Died before we were able to take samples of analysis.

Monkey No. 13. In this animal we made one count which showed erythrocytes 7,830,000 and the leucocytes 6,720. It died before another sample was taken.

Monkey No 14. The first blood count on this monkey gave the red cells as 5,260,000 and the white cells as 4,300. No more examinations were made.

Monkeys 15, 16, 17, and 18. Died before any blood counts were made.

Monkey No. 19. The blood count in this animal was, erythrocytes 5,000,000 and leucocytes 7,800. There were no eosinophiles. Regular general treatment for a month resulted in the red cells being 4,504,000 and the white cells 4,000. When the second attack came on, the erythrocytes were 6,002,000 and the leucocytes 21,800. There were present some normoblasts, myeloblasts, and a few microcytes. The animal began to get better. The counts after were decreased in leucocytes and there was also an anemia. Treatment was kept up. After some time the red cells were 2,512,000 in number and the white cells 12,200, with many poikilocytes, microcytes, and macrocytes. The last count showed some improvement,—the red cells being increased to 2,608,000 and the white cells decreased to 9,400. The animal is still alive.

Monkey No. 20. The first blood count on this monkey showed the erythrocytes to be 3,908,000 and the leucocytes 21,400. After definitely outlined treatment, the red cells increased to 4,552,000 and the white cells decreased to 12,900. Count at December 1st, was 5,424,000 for the erythrocytes and 7,400 for the leucocytes. A still later count showed the red cells increased to 5,672,000 and the leucocytes decreased to 6,200. This monkey caught cold and died in the course of a few days.

Monkey No. 21. No examination was made of this animal.

Monkey No. 22. The first blood examination of this monkey showed the red cells to be 5,468,000 and the leucocytes 33,600. It was treated and the erythrocytes increased to 6,252,000 and the leucocytes decreased to 23,700 in three weeks treatment. At the end of another month of treatment, the red cells were 6,440,000 and the leucocytes 23,000. This animal gradually improved until another count showed red cells as 6,344,000 and the white cells as 16,300. This monkey is now on another series.

Monkey No. 23. After this monkey had been treated for two weeks the blood count was 4,212,000 for the erythrocytes and 9,400 for the leucocytes. One month later the red cells were 5,512,000 and the white cells were 14,900. Treat-

ment was again instituted and after two months the red cells were 6,168,000 and the leucocytes 6,500. This animal is now on another series.

Monkey No. 24. This animal was dead before we determined anything from the blood.

Conclusions.

Therefore from our observations we conclude:

1. That the hematopoetic tissues can be influenced to normal functioning by osteopathic therapeutics.

2. That osteopathic therapeutics does increase body resistance.

3. That anemias due to infection can be materially benefited by osteopathy.

4. That the effects of osteopathic therapy lessens the cause of toxic elements in the blood stream.

EXPERIMENTAL AND CLINICAL STUDY OF GOITRE

CARL P. MCCONNELL, D. O., J. DEASON, D. O. AND H. L. COLLINS, D. O.

SERIES NO. 27.

The purpose of this series of experiments was to try to determine the relation of the interosseous lesions to enlargement and perverted function of the thyroids and to determine the region of the spine in which interosseous lesions were most active in influencing such changes.

LITERATURE.

So far as we know, there has been no extensive experimental work done along this line and we can therefore only refer to case reports. For a number of years, Dr. McConnell has observed that lesions of the upper cervical region seem to be most influential as causative factors of goitre, and that treatment directed to this region has effected favorable results in a large percentage of about eight hundred cases which he has had under observation.

METHOD OF STUDY.

For the purpose of determining the effects of osteopathic therapy in the treatment of goitres and for the purpose of determining the effects of interosseous lesions on the thyroids we selected twenty animals which were divided into two groups, as follows: The first ten animals were dogs which had enlarged thyroids, and the second ten animals were dogs which had no discoverable thyroid enlargement. All environmental conditions, food, water, exercise, etc., were kept the same for all animals used in this series.

The animals of the first groups were carefully observed for a period of from two to four weeks before treatment was begun. Careful measurements of the neck were made; their weight was regularly recorded and their general physical condition carefully noted. Osteopathic corrective treatment was applied to the upper cervical region only (second and fourth cervical) with the following results:

Dog No. 1. This animal was a male fox terrier about five years of age, very much emaciated and had a large pulsating goitre, and also a skin infection. The dog was well fed for one month and given lysol baths but there was no improvement in nutrition nor in the condition of the skin infection. The size of the goitre had not reduced. At the end of a month, treatment to the rigid and subluxated 2nd and 3rd cervicals wes begun. At the end of the first month of treatment there was some improvement in weight, the goitre was slightly reduced in size and the skin infection had improved. During the following month the goitre had reduced in size, the nutrition had continued to improve and the skin infection was completely relieved. This animal was observed for five months during which time the circumference of the neck had decreased from thirteen and three-fourths inches. The dog was fat and was in excellent physical condition. The goitre had not been completely reduced but nearly so and the perverted metabolism was completely normalized. A most interesting observation in this case was that with the improvement in the nutrition and the reduction of the goitre the animal's sexual activities were practically lost.

Dog No. 2. This animal was a female fox terrier about one year old and was in good condition, but not fat. A small goitre was palpable, with circumference of the neck over the gland being ten and three-fourths inches. A rigid condition of the second and third cervicals was found. Treatment was begun and continued for a period of three months during which time the circumference of the neck over the gland was reduced to nine and one-half inches.

Dog No. 3. This animal was a large mongrel, male, seemingly in good condition of nutrition and about five years of age. The dog had an extremely large pulsating goitre when received, the circumference of the neck over the gland being nineteen and one-half inches. Upon examination this animal was found to have a very marked rigidity of the entire upper cervical region and a specific rotation of the 3rd cervical. It was first treated by breaking up the rigidity as much as possible under anesthesia. This treatment was continued once a week for three weeks in the beginning, after which movement between the vertebræ could be accomplished without anesthesia. There was no noticeable change in the gland until about the end of the third week. At this time the gland began to soften and at the end of five weeks the circumference of the neck had reduced to seventeen and one-half inches. This animal was kept under treatment for a period of four months at the end of which time the cir-

cumference af the neck had reduced to fourteen and three-fourths inches but there was yet much noticeable enlargement.

Dog No. 4. This animal was a medium sized male cur, in good physical condition. There was a bi-lateral enlargement of the thyroids but no pulsation. The circumference of the neck over the gland was fourteen and one-fourth inches. A rigid condition of the second and third cervicals was readily palpable. Treatment was begun for the purpose of correction of this lesion and was continued twice weekly for a period of four weeks. The circumference of the neck over the gland during this time was reduced to thirteen inches, but the enlargement had not been completely reduced.

Dog No. 5. This was a small mongrel, female, about one year old. There was a large bilateral pulsating enlargement of the thyroid which seemed to interfere with respiration. There was also some nutritional disturbance; circumference of the neck over the gland was twelve and one-fourth inches. There was a readily palpable lesion in the 2nd and 3rd cervical vertebræ. Treatment was continued for a period of one month during which time the circumference of the neck was reduced to eleven inches.

Dog No. 6. This was a large cur, male, with readily palpable bi-lateral enlargement of the thyroid. The circumference of the neck over the gland was seventeen and one-half inches. This animal was treated for a period of six weeks during which time the circumference of the neck over the gland was reduced to fifteen and one-half inches. On post-mortem the glands were observed to be only very slightly larger than normal.

Dog No. 7. This animal was a medium sized Scotch terrier, male, with a bi-lateral pulsating goitre. The circumference of the neck over the gland when received was fifteen inches. A markedly rigid condition of the 2nd and 3rd cervicals was treated and normal movement was obtained during the six weeks of treatment. At the end of this time the circumference of the neck over the gland had been reduced to thirteen and one-half inches. There was no noticeable enlargement of the gland at the time the dog was killed.

Dog No. 8. This was a small Scotch terrier, male, with a bi-lateral goitre. There was a marked rotation of the third cervical to the left. The circumference of the neck over the gland was eleven and three-fourths inches. This animal was treated for a period of six weeks during which time the interosseous lesion was corrected and the accom-

panying rigidity was reduced. At the end of this period of treatment the circumference of the neck over the gland was nine and three-fourths inches and there was no noticeable or palpable enlargement of the gland.

Dog No. 9. This was a small black and tan, female, about two years old. A marked rigidity of the second and third cervicals was readily palpable. The circumference of the neck over the gland was twelve inches. This animal was treated for a period of four weeks during which time the circumference of the neck was reduced to eleven and one-fourth inches. The goitre in this case was not a large one, but complete reduction of the enlargement was effected during this period of treatment.

Dog No. 10. This was a large mongrel, female, in good physical condition, and had a very large bi-lateral goitre. It was kept for a period of two months as a control. This animal was not treated but was kept under exactly the same environment and food supply, etc., as the other dogs. During this time the circumference of the neck over the gland remained constant, at seventeen and three-fourth inches.

Dog No. 11. This was a medium sized brown and white female in excellent condition, but had a very marked bilateral goitre. The circumference of the neck when received was fourteen inches. This dog was kept for a period of three weeks without treatment during which time the circumference of the neck remained the same. For the next three weeks treatment was given twice weekly for the purpose of correcting the rigid 2nd and 3rd cervicals. During this period of time the circumference of the neck over the gland was reduced one inch.

In nearly all of the above animals it was observed that those cases in which the nutrition was poor there was much improvement as the size of the gland reduced. It should be noted that in all instances treatment was specific to the lesioned area only.

The following animals were carefully selected dogs of various ages in which no palpable enlargements of the thyroid glands could be discovered.

Dog No. 1A. This animal was kept for a period of three months during which time it was found to be in perfect condition. It was then lesioned (3rd cervical to the right) under anesthesia. After a period of one month there was a slight palpable enlargement of both thyroids.

Dog. No. 2A. Same results as above.

Dog No. 3A. This animal was accidentally killed before any results were obtained.

Dog No. 4A. This animal was lesioned rotation 2nd cervical to the right. It was kept for a period of six weeks during which time a very slight enlargement of the thyroids was palpable.

Dog No. 5A. This animal was lesioned, 2nd cervical rotated to the right, and kept for a period of five months during which time there was only a slight thyroid enlargement.

Dog No. 6A. This animal was lesioned, 3rd cervical rotated to the right and was kept for a period of six weeks, but there was no noticeable enlargement of the gland.

Dog No. 7A. This animal was lesioned, 3rd cervical rotated to the left. During the first five weeks after the lesioning there was no noticeable change in the thyroid but during the sixth and seventh weeks both glands materially increased in size. After about one week following the lesioning nutrition of the animal was somewhat impaired and the dog lost weight as the goitre developed.

Dog No. 8A. This animal was lesioned, 3rd cervical rotated to the left and was kept for a period of four weeks during which time no noticeable enlargement developed.

Dog No. 9A. This animal was lesioned 3rd cervical rotated to the left; was kept for a period of thirteen weeks during which time a marked enlargement of both thyroids had developed.

All dogs were killed by ether or chloroform and post-mortemed. The thyroid glands were carefully and promptly removed from all of the above dogs and a careful histological study was made with the following results:

Pathology.

We will briefly summarize the results of our pathological findings, rather than give a detailed report on each animal, for they are so similar that it would simply be a repetition in most cases.

The microscopic findings in both of these series of animals, those having goitres already existing and those in which the goitre was produced, are practically the same as regards quality. The amount or quantity of pathology varies from only a slight involvement to a severe or marked parenchymatous goitre. The goitres found in all cases were of the simple parenchymatous type. There was col-

loid deposit and active hyperplasia of the follicular epithelial cells of the gland. In some cases this was comparatively slight, possibly due to the animal's resistance or the length of time the animal was lesioned before death, or both.

In all cases where the goitre had pre-existed, there was evidence only of a simple parenchymatous goitre. In those animals in which the goitre was produced there was a mitosis or hyperplasia of the follicular cells, with slight irregular deposit of colloid material. In a few cases which had clinically shown marked enlargements, the colloid material was regularly and abundantly distributed throughout the thyroid, and the number of hyperplastic cells abundant. In one case a slight hyperemic condition was noted.

In dog No. 3, the amount of colloid material was not abundant and quite irregularly distributed, contrary to what we find in an untreated simple parenchymatous goitre.

The microscopic study of the tissues taken from the animals used in this series, has been very interesting and numerous questions have arisen and new side-issues opened, which we have not thought of before. For example, by what manner does the reduction of the thyroid take place and what is the structural change that takes place when a goitre is reduced or being reduced? What is the remote pathology, if any, in other tissues occurring as a result of thyroid enlargement?

We have been able to collect some data dealing with the above questions, but there are so many factors which may influence these that we prefer not to offer them until more work has been done, at which time we perhaps can make use of them.

Clinical Summary.

This short clinical summary is based upon an experience of several hundred cases. There can be no question that the majority of cases can be cured. General health (resistance) is an important factor. Then no doubt there is a point in the diseased condition wherein response is not forthcoming and surgical interference seems necessary.

There is a class of cases of enlarged thyroid that does not require any special attention to the gland, for just

as soon as the physiological requirements are met the gland returns to normal size. This no doubt accounts for the recorded cases wherein the osteopath has secured results by attention to the lumbar and dorsal alignment, etc., although as we shall see later there may be other factors in these particular cases.

But from a specific osteopathic viewpoint, interosseous lesions, from the second to fourth cervicals, particularly rotations between the second and third, are the primary factors. This requires close attention in diagnosis and treatment; the adjustment must be absolutely specific or disappointment will certainly result. This lesion seems to have a direct influence upon the vasomotors of the gland; and in many cases is a sufficient cause in itself, while in others some additional factor will be an exciting cause. No doubt other cervicals, upper dorsals and ribs, and possibly the clavicle, when lesioned, will influence the integrity of the gland (Dr. Still makes note of this in his writings). Direct treatment to the gland amounts to but little.

Lane, of England, claims good results from his short-circuiting operation. No doubt intestinal stasis by the retention of toxins may disturb the gland. Likewise cases of focal (septic) lesions of the tonsils, gums, etc., may be exciting causes. But at least, there will be found an impaired innervation of the thyroid, viz., lesion between the second and third or the third and fourth cervicals. It is always well to keep in mind the possibility of the so-called focal lesions.

Then attention to the pelvic organs should not be neglected; in some cases the exciting cause may arise here. Adjustment to the lower spine and innominate is necessary, as well as care to the viscera.

The above also applies to exophthalmic goitres. This probably starts as a trophoneurosis (vasomotor) due to the cervical lesions. Septic foci, particularly intestinal stasis, are frequent factors. Abderhalden, in his "Defensive Ferments," says: "Here (Basedow's disease) we find decomposition of the thymus gland, of the thyroid gland, and very often of the ovary." The cure of these cases

depends upon most careful attention to the cervical lesions and the general resistance. It requires time to re-establish normal glandular innervation, but it can be accomplished if the disease has not progressed too far.

The average length of treatment in the series of clinical cases has been three months. Complete reduction of the abnormal size is not always essential for a cure. Individual cases have required treatment from two weeks to a year or more. Treatment once a week or less often is best after a certain adjustment has been made. This refers to the specific thyroid technique; other factors in the individual case should be met according to the indications.

The clinical fact that stands out beyond all others is the disturbance of the gland's innervation, which should be met in a most precise manner.